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(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

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M. N. FORNEY, ... Editor and Proprietor.
FREDERICK HOBART, ... Associate Editor.

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NEW YORK, AUGUST, 1892.

A REQUEST for information from manufacturers of railroad material and supplies is presented in another column by Mr. Pethick, Managing Director of the Imperial Railroads of North China, which ought to be freely responded to. Mr. Pethick is trained in American railroad methods and is trying to introduce them in China; and while the field is comparatively a small one at present, it has great possibilities in the future.

THE compound locomotive occupies a good deal of space in the present number. No excuse is needed for this, since almost all the late developments of the locomotive have been on this line, and the interest felt in the question is increasing. Whether the double-expansion engine will have a permanent place on the railroad is still somewhat uncertain, but its careful trial is a matter which interests every one.

A TRIAL of electric motors is to be made on the Second Avenue line in New York, and probably on some other lines in that city. The trolley plan of running cars, which has been so much used, is hardly advisable in a city like New York, and in this case a storage battery system is to be used. The great objection to this system is the weight to be carried, but it is said that this has been partly overcome.

THE dead weight of the motor coming directly upon the track without the intervention of springs has been so far the great objection to electric street cars. There is little question about the working of the motors, but the difficulty has been to find rails which will stand the work and not cost too much.

THE Philadelphia & Reading Company has put a fast train on its line between Philadelphia and Atlantic City, which makes regularly the run of 55½ miles in 60 minutes. This train usually has eight cars, and sometimes an additional one. The road, it may be noted, is almost all level, and has very few curves.

NEW railroad construction for the first half of 1892 is reported by the *Railway Age* at 1,367 miles, a smaller total than for some time past. The greatest mileage reported in any State is 163 miles in New York, the second place being held by Montana, with 127 miles. The new mileage is pretty well distributed, a falling off in the South and Southwest and some increase in the Middle and Eastern States being apparent. The construction has been largely in short lines and branches, only one or two long lines being now under way.

THERE is always more track-laying in the second than in the first half of the year, but the indications are that the addition to railroad mileage this year will be less than 3,000 miles. More money is being spent now on improvements to existing roads than on extensions, and very few new lines of importance are in progress.

THE various bills presented in Congress to compel the adoption of automatic couplers and continuous brakes have been consolidated in one measure by the committee to which they were referred. This bill proposes to leave the adoption of a standard coupler to the Interstate Commerce Commission, in case the roads are unable to agree, and to compel its adoption within three years. The full text of the bill will be found on another page.

Action on the bill can hardly be taken at the present session; but it will probably be urged at the next session, with some probability of its passage.

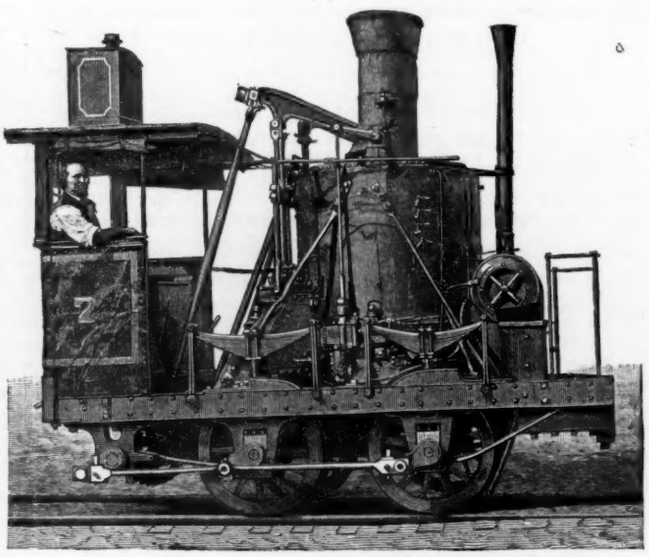
ENGLISH AND AMERICAN LOCOMOTIVES.

THE discussion of this subject, which has been carried on in these pages and those of *The Engineer*, has reached a stage in which its continuance will probably have little further interest to our readers. On June 17 our cotemporary gave another article, in which it was said that the editor of the RAILROAD AND ENGINEERING JOURNAL "insists on having the weights of *all* trains, including those on branch lines." This, he says, was given "in another form" in the table which was republished in these columns last November. Now it happens that in that table there is no intimation at all of the weight of trains. How it can be given in "another form" when weights are not mentioned surpasses our understanding. We gave a table showing that on 16,000 miles of our principal railroads the average consumption of coal for passenger trains, whose average weight was 130.3 tons, was 66.97 lbs., and on freight trains the consumption was 115.7 lbs., and the weight of trains 553.5 tons. The average consumption per ton per mile was .515 lb. for passenger trains and .209 for freight. To this *The Engineer* says the average consumption of all trains on British roads for six months was 37.53 lbs. of coal. Now obviously the key to the significance of these figures is the weight of the trains hauled. Our cotemporary seems unwilling or unable to comprehend what the average weight of *all* trains on a road or a number of roads means.

In its last article he meanders about the subject by giving the weights of the trains which the various representatives of the railways at the time of the Trent brake trials thought conformed to "normal practice." The greatest weight of the trains tested, exclusive of engine and tender, was 195 tons, and the lowest 135. This was in 1875, and he

says trains are heavier now than then, and that if we "had ever seen the work done on the London & North-western and Great Eastern lines during the tourist season, he would know that we have understated—not overstated—the weight of passenger trains." Esteemed cotemporary, you said the average number of passengers carried in the regular train of the Caledonian Railway was 120, and that it weighed 125 tons. What did you mean by "*regular*" train? We showed by the statistics of your Board of Trade that if by "regular" train you meant average train, that the Caledonian Railway was carrying passengers for less than any other railway in the world. We have not the least doubt of the fact that some of the passenger trains on your roads are heavy. The question at issue is, what is the average weight of all of them? We may remind you, too, that the dictionary meaning of the word "average," when used as an adjective, is "equal in amount to the sum of all the particular quantities of the same sort, divided by the number of them." The average weight of all the trains on a road or number of roads is the sum of the weights of all divided by the number of them, an elementary fact which somehow you have not been able or willing to grasp. You say, too, that we "entirely overlook the fact that American engines have to haul empty trains just as our own engines have to haul them." Now if the writer of this sentence knew more of the system of reports employed on American railroads, and made fewer assumptions, he would have known that all companies which report car mileage here reduce the mileage to a basis of loaded cars—that is, two empty cars are reported as equal to one loaded, or five empties as three loads. Our calculations have been made on this basis. Therefore when he says that we "take average consumption and divide it into the weights of loaded trains, quietly ignoring the circumstance that the trains when empty have to be returned whence they came," he has fallen into error, and his statement has the demerit that it is not true. In estimating the average number of freight cars per train given in our Table II, published last November, empty cars are counted as fractions of loaded cars, or, as it is expressed in some of the reports of the railroad companies, "freight car averages are based on loaded freight cars." Therefore if the average number of cars per train is multiplied by the average weight of loaded cars, it will give the correct average weight of trains. The "erroneous assumptions" which our cotemporary attributes to us are in his imagination only, and are the result of too much reliance on that faculty in making some of his statements of fact. There is a similar lack of cogency in some other statements which our cotemporary has made, and which seem to be due to the same cause.

Thus he says that "an American locomotive burning more coal per mile and running many more miles per year than an English engine must wear out sooner." This is a case of *inference* by imagination. Not the slightest evidence has been adduced to prove this bald assumption. It is purely gratuitous, and the inference has been drawn with a perfect disregard of all evidence. Our cotemporary has struggled under the weight of the statistics which we have given, and which show conclusively that the cost of repairs of American locomotives is less per mile run than that of English locomotives, notwithstanding that the former run farther in a given time, pull heavier trains, and that materials and labor here both cost more than they do in England. The significance of our figures, showing the cost of repairs and the service performed by American locomotives cannot be lessened by any exercise of his imagination. One important fact, too, we have not explained. This is that the cost of repairs, as reported by American railroads, covers the cost of rebuilding and replacing old locomotives which are worn out. If an engine becomes unfit for further service, and is broken up, and a new one built to take its place, the cost of the new machine is charged to repairs. In some cases, if the new locomotive is worth more than the old machine was when it was new, the difference in value is charged to some betterment account. The cost of repairs covers the cost of replacing worn-out locomotives with new ones. So far, then, as the system of keeping the accounts is concerned, American locomotives may be said to be immortal, and the cost of immortality is charged to "repairs." It will, therefore, be seen how entirely without foundation of fact the assertion of *The Engineer* is, that because they cost less for repairs, therefore they must wear out sooner.



"GRASSHOPPER" LOCOMOTIVE, BALTIMORE & OHIO RAILROAD.

It would be interesting, too, to know on what system the repair accounts on English roads are kept. Does the cost of repairs as reported cover the cost of replacing worn-out engines? If it does not, then to that extent is the lesser cost of repairs here still more favorable to American locomotives than our figures have shown it to be.

The danger of depending upon one's imagination for facts is shown in a still more striking way, in our cotemporary's response to our statement that there are locomotives in this country which have been in continuous service for over 50 years. To this our imaginer says:

> If there be really a locomotive 50 years old running in America, it was made, we can assure him, in England. . . . The oldest engine, perhaps, in America which continued working until recently was the *Sampson*, built by Timothy Hackworth, in 1838, and it was exported to Nova Scotia in 1839 with two similar engines, to convey coal from the Albion mines at Stellerton to Pictou Harbor, a distance of seven miles. A simple subtraction sum shows that it is 53 years since 1839. The engine was at work in 1882. Our cotemporary has got,

to use an Americanism, "a little mixed," we think, in his dates.

Our cotemporary on the other side the Atlantic should, we think, lay to heart the maxim that "there is nothing so uncertain as those things of which we are not quite sure." As he has quoted the American language, we may respond in our vernacular by saying that he "is barking up the wrong tree." To make this quite obvious, a little history will be recited, which, it is true, has been told often before, and for that reason there is less excuse for his waywardness. Our historical note and the illustration herewith are taken from "The American Railway; its Construction, Development, Management, and Appliances," published by Charles Scribner's Sons. In that volume it is said:

> In 1831 the Baltimore & Ohio Railroad Company offered a premium of $4,000 "for the most approved engine which shall be delivered for trial upon the road on or before June 1, 1831; and $3,500 for the engine which shall be adjudged the next best." The requirements were as follows:
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> "The engine, when in operation, must not exceed three and one-half tons weight, and must, on a level road, be capable of drawing day by day 15 tons, inclusive of the weight of wagons, 15 miles per hour."
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> In pursuance of this call upon American genius three locomotives were produced, but only one of these was made to answer any useful purpose. This engine, the "York," was built at York, Pa., and was brought to Baltimore over the turnpike on wagons. It was built by Davis & Gartner, and was designed by Phineas Davis, of that firm, whose trade and business was that of a watch and clock-maker. After undergoing certain modifications, it was found capable of performing what was required by the company. After thoroughly testing this engine, Mr. Davis built others, which were the progenitors of the "grasshopper" engines (illustrated by the engraving herewith), which were used for so many years on the Baltimore & Ohio Railroad. It is a remarkable fact that three of these are still in use on that road, and have been in continuous service for over 50 years. Probably there is no locomotive in existence which has had so long an *active* life.

After designing this first engine and building others Davis was killed during a trial of one of his own machines. After his death the business of building his locomotives was taken up by Gillingham & Winans in Baltimore. The three engines referred to above are still at work on the Baltimore & Ohio Road. They were built in 1835, and have consequently been in service 57 years. We cannot be quite certain at the time of writing whether these three machines were built by Davis & Gartner or by Gillingham & Winans. It is certain though that they were neither designed nor made in England. The engraving herewith was made from a photograph taken about 15 years ago. Since then the engines have been somewhat altered, but not to any material extent. Originally they had four-wheeled tenders. A tank on the engine frame has since been substituted. As shown by the engraving, when they were first built they had a fan-blower which also acted as feed-water heater. This is shown at the base of the exhaust pipe. The required draft was produced by the fan, which was driven by the exhaust steam. The fan was taken off at the time that other alterations were made, and the exhaust was turned up the chimney in the usual way. About 10 or 12 years ago one of the master mechanics at the Mt. Clare shops of the Baltimore & Ohio Railroad told the writer that these engines were so efficient in switching service—in which they were then and have since been employed—that he was strongly disposed at that time to build some more just like them. So far as we know, and we have had excellent opportunities of getting information, these engines have been in continuous use ever since they have been built, excepting during such times as they have been laid up for repairs.

The Engineer says that his "cotemporary [meaning us] has no reason to boast about old engines." We believe that the above statement, while it may not be a good reason for "boasting," will give every American engineer good reason for being proud of the lineage of American locomotives, of which the old grasshoppers are progenitors.

Our cotemporary has charged us with a misstatement of historical facts; will it have the magnanimity to retract the charge?

He asks, "Does the art of building durable locomotives survive only in the United States?" We say, No, it does not, and no one with any adequate knowledge of some of the admirable work which is done in English workshops would say that durable locomotives cannot or are not made there; but we do believe that the art of designing them so as to give the maximum of endurance at a minimum of cost has been carried to a higher degree of perfection here than it has been in his own more conservative country.

Our readers will probably be edified by some very interesting testimony bearing upon the subject of this discussion, which has recently come from our Antipodes. A Royal Commission was appointed some time ago "to inquire into the alleged defective working and unsuitability of the Baldwin engines," which had been ordered for the New South Wales Railway. At a meeting of that Commission, held in Sidney on May 18 of this year, Mr. Eddy, Chief Commissioner of Railways for the Colony of New South Wales, made an elaborate statement to explain the policy that animated the Railway Commissioners in the new departure they made in ordering the Baldwin engines. This statement is very interesting, but is too long to reproduce here; but, among other things, Mr. Eddy said:

> The (Baldwin) passenger and goods engines have already run over 450,000 miles, and the average failures are less than with other engines of somewhat similar type. The returns which have been already supplied to the Commission show, I think, that the ordinary running repairs are very moderate when the heavy work the engines are doing is considered. . . .
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> Previously to the giving of the present order the Government had very satisfactory proof of the class of work turned out by the Baldwin Company—that from having supplied 33 locomotives for the New South Wales railways and 91 motors for our tramways. It was, therefore, no new experiment or departure on our part to obtain supplies from that firm; and as one of the leading partners in the firm had some years ago spent a considerable time in the Colony, they were in an exceptional position to understand our requirements, which were most urgent.
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> Doubtless the average amount of fuel burned per train mile is less on English than on American lines, yet if the computation were per ton of train hauled per mile, it would be found that the consumption is less in America than it is on English lines, without taking into consideration the difference in the grades and curves. In my opinion there are many features in American locomotives which might with advantage be adopted by English engineers.
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> With our heavy grades and curves and growing traffic on single lines, a new departure in locomotive power was absolutely necessary, and the results which are beginning to be accomplished clearly demonstrates the wisdom of the action of the Commissioners, the earnings per train mile for the quarter ending March 31 last showing at the rate of 7*s.* 5½*d.* as against 6*s.* 6*d* for the same quarter of 1890; this is upon a total mileage of over 2,000,000 of miles in the quarter. That alone will carry conviction to any one who thinks of railway management. The amount of assisting engine miles (*i.e.*, a second engine with trains) is also being largely reduced.
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> With regard to the American goods engines, from very care-

fully prepared returns made by the out-door superintendent and the chief traffic manager, it would appear that during the months of February and March 15 these engines on the western lines saved 27,000 miles, as against working the traffic in absolute full train loads by the most powerful of our ordinary goods engines. These are two light months of the year, and it is estimated that on the whole year's working a saving of about 220,000 miles will be effected. Another great advantage gained is the reduction in risk of accident by having fewer trains on the lines, and the fewer delays that will be experienced in passing the traffic along the single lines. To illustrate this it may be mentioned that in February, between Penrith and Dubbo, 15,219 wagons were moved by 551 trains worked by the American engines, whereas it would have required 796 trains worked by the ordinary engines to have moved this number of wagons.

From still more recent private advices from Australia we learn that indicator diagrams have shown that some of the (Baldwin) engines, on the New South Wales Railways, have exerted a steady tractive force of over 19,000 lbs. when hauling a train of passenger carriages, weighing 144 gross tons, up a gradient of 1 in 30, or 176 ft. per mile. The load was, of course, exclusive of the weight of engine and tender. The weight of the train was obtained by actual weighing on a weigh-bridge. The length of this incline is 2 miles of 1 in 30, or 176 ft. per mile, preceded by ¾ mile of 1 in 33, or 160 ft. per mile.

A point which thus far has not been touched upon in this discussion is the relative cost of British and Yankee locomotives. A comparison of prices from competitive tenders of English and American builders on the same specifications would be interesting, but such data are not accessible to us. But we have it on the authority of an engineer of a large locomotive company here that 1,500 workmen will build 300 American locomotives per year, or 4,500 men will build three locomotives per day; in other words, counting 300 working days in the year, this would be equal to an annual production of 900 engines. That is, there are 1,500 days' (of 10 hours) work on an American locomotive. Our statement is, of course, a very rough one, but it is not believed that it is much out of the way. This rate of production would include engines of a great variety of sizes, big and little, but heavy engines would predominate. How many days' work is there on an average English locomotive?

As a sort of final recapitulation of the subject under dispute, the Editor of *The Engineer* ejaculates—"We challenge our cotemporary to prove that any non-compound American locomotive has ever hauled a train of 178 tons at 50 to 60 miles an hour with a consumption of 30.6 lbs. of coal per mile"—this being the performance of the engine on the Great Northern Railway, and is equal to .172 lb. of coal per ton per mile. At the present writing we are not able to match the figures which *The Engineer* quotes, but if our cotemporary "has a memory adequate to the trifling task"—to quote his own words—of recalling the figures in the table which we published in our February number, he will there see a report of a train weighing, exclusive of engine and tender, 341 tons, which was hauled 143 miles at an average speed of 45.64 miles per hour, with a consumption of .178 lb. per ton per mile, and another train weighing 261.5 tons was hauled at a speed of 41.85 miles per hour with an expenditure of only .117 lb. of coal per ton per mile. Considering the weight of the trains, this we submit is a more remarkable performance than that on the Great Northern Railway referred to by our cotemporary.

Our cotemporary also asks: "What, for example, does Mr. Buchanan's great engine burn per mile, hauling a train of 117 tons at 50 miles an hour?" We regret that we are not able to answer this inquiry at the present time. Unfortunately for this discussion, but perhaps luckily for the New York Central Railroad, we do not control the engines on that line. No regular account of fuel consumption is kept on that road. Some partial tests have been made of the fuel consumption of the engines referred to, but the results have not yet been made public. But we hope to be able to give the results of more complete tests before long. In the mean while, we may give the recent performance of some of these engines in hauling trains from Buffalo to New York, a distance of 440 miles. On July 7 the train which left Buffalo at 7 A.M. and reached New York at 6.10 P.M. consisted of 1 baggage car, 4 coaches, 1 drawing-room car, 1 dining car and 6 sleepers, or 13 cars altogether. The calculated weight of this train, exclusive of engine and tender, is 409 tons (of 2,240 lbs.). Three engines were employed to haul the train: one from Buffalo to Syracuse, 149½ miles; another from Syracuse to Albany, 147½ miles, and a third from Albany to New York, 143 miles. The schedule time, including 6 stops, is 11 hours, or 40 miles per hour. In making the above run, 10 minutes was lost between Syracuse and Albany. No assisting engines were used.

On July 15 a train consisting of 1 baggage, 1 mail, 1 coach, 1 dining, 1 drawing-room and 5 sleeping cars, or 10 cars altogether, was hauled on the same schedule time. Its calculated weight was 328 tons. With this train one of the engines made up 10 minutes between Syracuse and Albany.

These examples of the daily work on the New York Central Railroad may make it clear to the *Engineer* why locomotives as heavy as those designed by Mr. Buchanan are used in hauling the Empire Express. "If," he says, "I was called upon to design an engine to haul the Empire Express alone, consisting of four cars only, and weighing 117 tons, I would make one which would be more economical in fuel than our present engines are; but after this train commenced running, a fifth car was added, and quite recently a sixth one had to be taken. Our engines must be able not only to haul the increased number of cars on this train, but also to take our other trains, examples of which are given above. If the engines were not able to do so, more of them would be required, and we could not get as great an annual mileage out of them."

In other words, economy in fuel is sacrificed for other more important considerations; and this policy is often followed by locomotive engineers and railroad managers in this country.

If the ejaculatory form of discussion is to be employed, and if our esteemed disputant can grasp the idea of what the average weight of *all* trains on a great railroad means, we will "challenge" him to prove that any great railroad operated by English locomotives is hauling *all* its freight trains with an expenditure of coal of 0.160 lb. per ton per train exclusive of engines, the consumption on the Michigan Central Road for the year 1890, or that on a dozen English roads it is as low as 0.215 lb., the average consumption on 12 American roads given in our Table V, published last December.

We challenge him to show that the average annual mileage of English locomotives anywhere in the world is equal to what we have shown it is on our American roads.

We challenge him to show that any English locomotive has burned as much coal per square foot of grate per

hour as has been and is being burned in locomotives here.

We challenge him to show that any English engines are able to and do haul as heavy trains as are hauled here.

We challenge him to show that the cost of repairs of English locomotives is as low as our data indicate that of American engines is.

We challenge him to show that the cost of maintaining the "immortality" of locomotives in his country is as little as we have shown it is here.

We challenge him to show that the total cost of the service of English locomotives, per ton hauled, on any road with a heavy traffic, is as little as we have shown it is on roads with such a traffic and equipped with American engines.

We challenge him to show that the number of days or hours' work required to build an English locomotive is as little as is required to build an American locomotive.

We challenge him to show that their locomotives run as fast as ours do, but as no one ought to believe his own brother on this subject, reliable evidence should be submitted with the showing.

EXPERIMENTS WITH DYNAMITE SHELL.

SINCE the first discovery of high explosives, nearly half a century ago, efforts looking to their employment in warfare have been unceasing. The early attempts to use gun-cotton as the propelling agent in fire-arms proved so disastrous that the use of high explosive compounds in the military service was for many years restricted to submarine mining and the like; but the proved ineffectiveness of ordinary shell fire against armor-plate has, within the last decade, awakened renewed interest in the subject, particularly in the direction of finding a way of using high explosives instead of gunpowder as the bursting charge of projectiles.

The extreme sensitiveness to shock of nitro-glycerine, dynamite, and all of the earlier forms of high explosives seemed an insuperable barrier to their use in arms whose propelling agent was gunpowder. Although the success of the dynamite air-gun was one solution to the problem, efforts to make possible the use of a high explosive bursting charge in ordinary artillery projectiles were not abandoned. Lieutenant Graydon, Dr. Justin and others, in this country and abroad, have been at work upon the problem. Their experiments have generally resulted, as did the earlier ones of Dr. Justin, in the destruction of the gun when any but the most moderate charges were used.

Generally speaking, the end to be attained has been sought by subdividing the charge of explosive material, and by various methods of cushioning it, so as to reduce to a minimum the initial shock at discharge.

If the press accounts are to be relied upon, the last experiment by Dr. Justin, at Perryville, N. Y., on June 20 proved successful. A 5½-in. Parrott and a 9-in. Blakeley rifle were used. From the former six and from the latter seven shots were fired. The projectile from the smaller gun weighed about 26 lbs. and carried 6½ lbs. of explosive gelatine; those from the larger gun weighed from 214 to 254 lbs., and were charged with from 30 to 36½ lbs. of the same compounds. The target was the rocky face of a precipice, except that two of the former projectiles were fired through a ⅝-in. and one of the latter through a 3-in. steel plate—the projectiles in each case getting through the plate and being exploded in the backing by a delayed-action fuse. In Dr. Justin's projectile the explosive charge is contained in a separate magazine or cylinder, which, in the last experiment, was of wood instead of metal, as formerly.

No one will deny that great credit is due Dr. Justin for his persistency in following up these experiments after many disheartening failures, and his success is well deserved. Still it must be admitted that while these experiments have been going on success in the use of high explosives in powder guns has been practically achieved along other lines than in the employment of specially constructed shell.

The exhaustive experiments which have been carried on in efforts to perfect a smokeless powder have led to the discovery of a number of high explosive compounds which are practically insensible to explosion by shock or friction. Of the picrate mixtures, the French *melinite* is a well-known example, and one which has been repeatedly and safely used in charging shell. Another and far more powerful class are the nitro-glycerine and nitro-cellulose compounds. In their preparation about equal quantities of nitro-glycerine and cellulose cotton are used, to which is added a solvent, as acetone or acetic ether, and usually a slowing agent, as camphor, tannic acid, or castor-oil. After the evaporation of the solvent the resulting product is a gelatinous mass which may be pressed into sheets or granulated into any desired shape or size, and, dependent upon the varying proportions and manipulation of the ingredients, known as *explosive gelatine*, *balistite*, *cordite*, etc.

Granting that it is now quite possible to fire the more stable of the high explosives in shell from powder guns, the problem of getting a projectile so charged through an armor-plate is by no means solved. To detonate any high explosive compounds, stable enough to be fired from a gun, requires a powerful detonating primer or fuse, and it is here that the difficulty lies. The primer in any case must be sensitive, usually of dry gun-cotton or some high explosive mixture, which, although it may safely withstand the shock of discharge, is unable to withstand the shock and heat following impact upon armor-plate of even moderate thickness; and explosion takes place before any great penetration is achieved. The experiments made in France and elsewhere seem to have clearly demonstrated that a steel plate of 4 or at most 5 in. in thickness is sufficient to explode any shell charged with a high explosive.

It might be added that the success of Dr. Justin's, or any other similar invention, will in nowise destroy the value of the dynamite air-gun, as the newspaper critics so readily conclude. This is not only for the reason above given, but also because the projectiles of the largest guns can contain only a very limited charge of explosive material, while the projectile of the dynamite gun is a veritable torpedo, with a charge of many hundred pounds, and capable of destroying where the other missile would explode harmlessly upon impact.

NEW PUBLICATIONS.

THE OFFICIAL RAILWAY LIST. 1892. Chicago; the *Railway Purchasing Agent* Company. Price, $2 in cloth; $3 in flexible leather.

This is the new number of the *Official List*, which is now well

known and from its long-continued publication has become a standard hand-book. It gives a directory of railroad officers, including not only the general officers, but also those in the motive power, road and car departments.

The essential point in such a work is correctness, and the editors seem to have taken much pains to make it correct and bring it up to date, and this is all that can be expected. Constant use of previous numbers has shown them to be generally reliable, and this is certainly the best test that can be applied.

REPORT OF THE BOARD OF STATE ENGINEERS OF THE STATE OF LOUISIANA FROM APRIL 20, 1890, TO APRIL 20, 1892. Henry B. Richardson, Chief State Engineer; Sidney F. Lewis, H. B. Thompson, Frank M. Kerr, Arsene Perrilliat, Assistants. New Orleans; State Printers.

The work of the State Engineer in Louisiana differs in its nature from that assigned to the engineers of any other State, except perhaps Arkansas and Mississippi. His business is the construction and supervision of the great system of levees which protects a large part of the State from the waters of the Mississippi and its tributaries. The report before us gives many interesting particulars relating to this work, the extent of which will be seen from the statement that during the two years covered it involved the building of 171.11 miles of new levee and the raising and enlargement of 347.45 miles, besides the building of 12.70 miles and the enlargement of 18.76 miles in Arkansas, which formed an essential part of the system. This work required a total of 18,481,151 cub. yds. of embankment and an expenditure of $3,632,105.

The Louisiana system now includes 807 miles of levee on the Mississippi alone, besides many miles on the Ouachita, Tensas, Atchafalaya and other streams. Somewhat over half of these are reported at proper grade and in good condition, while about one-quarter of the whole need raising, and the remaining quarter strengthening or other improvement.

This work certainly requires great care, promptness in emergencies, and a variety of resources, and is altogether calculated to call into action the best faculties of the engineer.

THE MICHIGAN ENGINEERS' ANNUAL FOR 1892. Lansing, Mich.; published for the Michigan Engineering Society, F. Hodgman, Secretary.

This volume gives the proceedings of the Michigan Engineering Society for the year, including a number of interesting papers, and the discussions at the annual meeting, which covered a variety of topics. Among the subjects treated are Michigan Building Stones; Hydrographic Surveying; Computation of Earthwork; Surveying Instruments; Disposal of Sewage; Engineering for Cemeteries; besides a number of others equally practical and serviceable. An appendix gives the points involved in a number of recent legal decisions relating to surveys and other matters affecting the work of an engineer.

REPORT OF THE DIVISION OF FORESTRY, DEPARTMENT OF AGRICULTURE, FOR 1891. B. E. Fernow, Chief of Division. Washington; Government Printing Office.

This report contains a statement of the work done during the year by the Division of Forestry, and in addition a discussion of some subjects of general interest in connection with that work. These include Forest Planting Experiments, Forest Reservations and the Kinds and Distribution of the Southern Lumber Pines.

The Chief of the Forestry Division is very much in earnest in his work, the true importance of which is hardly yet appreciated as it ought to be. Forestry is not yet understood in this country, and the extent to which the reckless misuse of our timber resources has proceeded is realized only by a few. The work of this Division must be, for some time to come, chiefly educational, and requires both zeal and knowledge for its conduct. Engineers especially ought to appreciate its great importance; many of them doubtless do so, and are willing to give what aid they can to those who have it in their especial charge.

DESCRIPTIVE INDEX OF CURRENT ENGINEERING LITERATURE: VOLUME I, 1884–1891, INCLUSIVE. Chicago; published by the Board of Managers of the Association of Engineering Societies, John W. Weston, Secretary.

This volume is a reproduction and rearrangement of the "Index Notes" which have appeared monthly in the *Journal* of the Association of Engineering Societies for seven years past. They have been carefully rearranged in proper alphabetical order, with numerous cross-references and a systematic classification by subjects.

It is not by any means claimed that this is a complete index to current technical literature; but it contains over 11,000 notes and references, and it is believed to contain nearly all the periodical and society papers of importance appearing during the seven years covered.

As to society proceedings this claim is probably correct, but the periodical index is hardly as full as might be desired, and even a short examination discloses many omissions. Nevertheless the book will be of service to readers, and will often save them much time and trouble in hunting up the literature of a subject upon which they need information.

RAILWAY CAR CONSTRUCTION. *A Work Describing in Detail and Illustrating with Scale Drawings the Different Varieties of American Cars as now Built.* By William Voss. New York, R. M. Van Arsdale, Morse Building.

In his preface the Author of this book says, very truly, that "we have books on all conceivable subjects, but absolutely nothing, excepting the reports and Dictionary of the Master Car-Builders' Association, on the subject under consideration." Considering the enormous interests involved in car construction, it is remarkable that there has been no treatise in any language on that subject until the appearance of the one which is the subject of this notice. The Author, therefore, had an inviting field and an opportunity seldom offered to a maker of a book. He was induced, he says, when in charge of the car department of a Western railroad a few years ago to write a series of articles on the construction of cars for publication in the *National Car and Locomotive Builder.* It was then the intention to publish them in book form. He disclaims having any literary training to qualify him for the work, and says he engaged in the enterprise much against his inclination. The railroad public may be congratulated on the fact that his disinclination to undertaking the work was overcome, and that he has given it the volume before us.

It is true that it can hardly be regarded as a systematic treatise on the subject, and the title which would perhaps describe it best would be, Notes on Practical Car Building. The subject of car construction is a very much bigger one than most persons are apt to suppose it is, and covers a much wider range of topics than appears at a first glance. Some of these have not been discussed at all in "Railway Car Construction," and others have been treated so briefly and superficially as to leave very much of value and interest relating to them unsaid.

While the Author's want of training and experience, as a maker of books, is indicated in many places, no lack of practical skill or experience, which is of very much more importance in writing such a book, is anywhere apparent.

The book measures 8 × 10½ in., and contains 177 pages and about the same number of engravings. These are nearly all

outline illustrations of the details of cars, made by the "wax process," which leaves nothing to be desired in their execution.

The subjects treated of in the different chapters are: Freight-Car Bodies; Draw-bars and their Attachments; Floors and Framing; Sheathing and Roofs; Doors; Stock-Car Bodies; Platform or Flat Cars; Coal, Ore and Refrigerator Cars; Freight-Car Trucks; Truck Frames; Swing-Motion Trucks; Freight-Car Brakes; Power Brakes; Passenger Cars; Dimensions and Floor Frames; Platforms and Couplers; Passenger-Car Framing; Passenger-Car Superstructures; Passenger-Car Trucks; Pullman's Palace Cars; Wagner's Palace Cars; Pennsylvania Railroad's Standard Passenger Car; Pennsylvania Standard Passenger-Car Truck; Standard Passenger Car of New York Central Railroad; Boston & Albany Railroad's Standard Passenger Car; Standards adopted by the Master Car-Builders' and Master Mechanics' Association; and Code of Rules of Master Car-Builders' Association Governing the Condition of and Repairs to Freight Cars.

These subjects are none of them discussed in a comprehensive or systematic way, but what is said of them is in the form of what might be called running notes or observations. As an illustration of this method of treatment, the following paragraph on Body Bolsters, taken from the first chapter, may be quoted. Of these it is said:

The body-bolster, when made of wood, has a cross-section of about 5 × 14 in. It is locked to the side sills and floor timbers in the manner shown in fig. 9, and fastened to each of them with two ⅝-in. bolts. Those passing through the center timbers are also used to secure the body center-plate, and for this reason are made of ¾-in. iron when four bolts and of ⅞-in. when only two are used. Each bolster is trussed with 1¼ in. iron rods. These may be continuous, but are oftener made with a flat iron center piece or yoke to give a better bearing on the center timbers and to facilitate repairs. In the sketch this yoke is made of ½ by 2½-in. iron, with a pocket welded on each end to receive the nut of the truss-rod, which latter can be replaced when broken in a very short time and without cutting the floor. Fig. 10 shows another form also very extensively used. The end of the truss-rod is provided with a jaw which is bolted to the flat center piece, making a very strong truss, if not so convenient as the other. Blocks of 4 × 5-in. oak are placed on top of the bolster, both to preserve the distance of the sills and elevate the body truss-rods, which latter rest in cast-iron saddles let into these blocks. The space between the center timbers is filled with an oak block to properly support the bolster-truss and center-pin socket. The bolster of a flat car is placed flush with the bottom edge of the side sills, and framed to them with mortise and tenon, the truss-rods passing through the latter, and are provided with a suitable bevel washer.

The descriptions and the observations all through the book are those of a practical car-builder accustomed daily to meet the difficulties of construction and repair. He has troubled himself very little with theories or general principles of any kind. A car has presented itself to him as a structure not built in accordance with any particular theory or on any general principles, but to fulfill certain practical requirements of service and endurance. The defects of construction have revealed themselves to him in their demands for repairs, and until these have manifested themselves in that way he has not bothered himself much about theories of any kind.

Now there can be no doubt that if the general principles of car construction had been adequately discussed, the value of the book would have been much increased; but if we were compelled to choose between a book without any of the science of construction and an abundance of practical knowledge, like the one before us, and another giving all the science and none of the experience of a car-builder, we, and probably most railroad men, would prefer the former.

The general comment on the book is that, while it does not fulfill the demands of a comprehensive treatise on the subject, it is nevertheless a valuable contribution to its literature, and one which will be found generally useful to practical men.

One omission, however, ought to be condemned in the most unrelenting way—the book is without any alphabetical index whatsoever, excepting to the advertisements, which had better be left out. This omission is inexcusable in either the Author or publisher, and ought to be supplied when a new edition is published.

THE CAIRO BRIDGE. REPORT OF GEORGE S. MORISON, CHIEF ENGINEER, TO THE PRESIDENT OF THE CHICAGO, ST. LOUIS & NEW ORLEANS RAILROAD COMPANY. Chicago.

A review of this work would hardly be possible or profitable without republishing a very considerable part of it. It may be sufficient to say that it is another one of the admirable monographs on great bridges for which the engineering public is indebted to Mr. Morison. A more complete account of the structure could hardly be given. It includes full descriptions of the work on the substructure, the superstructure and the manner of its erection, with the contracts and specifications and records of the daily progress of the work and of the tests of the material.

The Cairo Bridge has been before referred to in our columns; crossing the Mississippi at a point where the nature of the bottom required special care in foundations, the most difficult work involved was in locating and building the piers and abutments, and the methods adopted in this work were very interesting.

The drawings accompanying the monograph give maps, views of the different piers, details of the construction of the caissons, and very complete details of all the steel work.

It may be added that the Cairo Bridge proper consists of nine through and three deck spans; two of the through spans are each 518.5 ft. long and the others are 400 ft. each. The three deck spans are 249 ft. each, the total length of the bridge proper being 4,644 ft. The viaduct on the Kentucky approach consists of 21 spans of 150 ft. each and one span of 106.25 ft., while the Illinois viaduct consists of 17 spans of 150 ft. each, and one of 106.25 ft. The total length of the metal work from end to end is 10,560 ft., making it the longest metallic structure across a river in the world. In addition to this metal structure there are in the two approaches 9,901 ft. of timber trestle, making the entire length 20,461 ft., or 3⅞ miles.

TRADE CATALOGUES.

Car Seats, Chairs, etc. Illustrated Catalogue of the Wakefield Rattan Company, Boston.

This catalogue illustrates and describes a variety of patterns of car-seats and chairs. In car-seats the Company does not confine itself to the rattan seats which are its specialty, but furnishes also seats upholstered in the usual way. It is a great pity that rattan is not more generally used; for suburban cars especially it makes a very desirable seat, easily cleaned and comfortable. Any one who has stepped into a car with rattan seats on a summer day has doubtless realized a comforting sense of coolness and cleanliness, which made the car a pleasant contrast to one with plush—and especially *red* plush—seats.

Presses, Drop-hammers, Shears, Dies and Special Machinery. Illustrated Catalogue of the E. W. Bliss Company, Brooklyn, N. Y.

The E. W. Bliss Company not long since absorbed its chief rival in business, the Stiles & Parker Press Company, and now practically controls its peculiar branch of business. Of the extent and importance of this branch some idea can be formed from the catalogue now before us. Very few, if any, books of the kind can be found which illustrate so great a variety of tools. The drop-hammer and the press have grown

to be important factors in many branches of metal manufacture, and they are found here in almost every variety. Stamping-presses, drawing-presses, shears, dies and a large number of similar tools are included; the shops also make milling machines, boring-mills and lathes, and undertake the construction of special machines.

As may be supposed, the catalogue is a work of considerable size, making a solid volume of 390 pages. The illustrations are generally very good.

Steam Engines and Boilers. Catalogue of the Watertown Steam Engine Company, Watertown, N. Y. Illustrated.

This catalogue contains illustrated descriptions of a number of engines built by the Company named. The different varieties include an automatic cut-off engine for general service; a stationary engine of somewhat similar design for heavy work; the "Excelsior" straight-line engine, a type especially designed for general work, and several patterns of portable engines mounted upon the boiler. Of these latter several are so arranged that they can be removed and placed on a separate foundation when desired. The catalogue also illustrates several patterns of boiler both of the cylinder and locomotive type. In addition to these, the Company also builds a traction engine which can be used as a portable engine for running agricultural machinery as well as for hauling heavy loads over a road.

Detroit Sight-Feed Lubricators. Detroit Lubricator Company, Detroit, Mich. Illustrated.

This illustrated catalogue gives a description of the various patterns of sight-feed lubricators made by the Detroit Lubricator Company, the quality of which is well known. In addition to these, the Company manufactures the Garfield injector, a special lubricator for air-brake pumps and a number of smaller devices for locomotive and other engine work. A very neat device for the steam connections of locomotive boilers presents so many excellent points that we have illustrated it on another page. Another device for locomotives which is well known is the Pendrey throttle-valve.

Corrugated Steel Furnaces. Illustrated Catalogue of the Continental Iron Works, Brooklyn, N. Y.

The use of corrugated iron furnaces for marine and stationary boilers has become so general that there is very little to be said about their application. This very handsomely illustrated catalogue shows the arrangements adopted with these furnaces in a large number of different boilers, including those for several of the new cruisers, several for other steamships, and a number of stationary boilers. A long list of vessels on which the corrugated furnace is in use is also given, and the catalogue concludes with rules for calculating the working pressure allowable on such furnaces according to the rules of the United States Supervising Inspectors of steam-vessels.

Jewett Anti-Friction for Car Bodies. Jewett Supply Company, Boston, Mass.

This catalogue contains a description of the Jewett anti-friction device, which consists of a system of roller bearings for the center-pins and the side-bearings of cars. The system is now being tested on the Boston & Albany and the New York & New England roads, so far with very good results.

CURRENT READING.

THE July number of the JOURNAL of the Military Service Institute has articles on Smokeless Powders, by Captain Clark; the Prussian Great General Staff, by Captain Bingham; Artillery Service in the Rebellion, by General Tidball; Practical Drill for Infantry, by Lieutenant Johnson; the French Grand Manœuvers of 1891, by Captain Chester; Practical Workings of Rifle Practice, by General Wingate; the Civil War in Chile, by Captain O'Connell. There are also several translations and notes of interest.

In the July number of GOLDTHWAITE'S GEOGRAPHICAL MAGAZINE there are articles on Columbus and his Times; Physiographic Aspects of New York; Patagonia; a Desert Journey; Chinese Cities; the Rubber Forests of the Amazon; the Pan-American Railroad, and a number of other topics of interest.

The July number of GOOD ROADS contains plenty of excellent material, including articles on several timely topics and a continuation of Editor Potter's papers on Dirt Roads and Gravel Roads. No better work can be done than to circulate this magazine as widely as possible.

A new monthly publication called the DIGEST OF ELECTRICAL PATENTS has been started under the charge of Mr. Ralph W. Pope, a well-known electrical engineer. It proposes to give each month a classified list of all patents issued on electrical matters, with condensed synopses of their claims, etc. It is published at No. 12 West Thirty-first Street, New York.

The August number of SCRIBNER'S MAGAZINE is the annual "Fiction Number," and is given up chiefly to short stories, which are perhaps the best reading for the prevailing weather. There is something in the number besides these, however; the series on Historic Moments includes a description of the driving of the last spike on the Union Pacific, written by the late Sidney Dillon. Professor Shaler has an interesting article on Icebergs, and Walter Besant writes of the Poor in London.

The last number of the PROCEEDINGS of the United States Naval Institute publishes the prize essay for 1892, which is by William Laird Clowes, on Torpedo Boats; their Organization and Management. It gives also Captain Schley's official report on the *Baltimore*. Other articles are on Electric Welded Projectiles, by H. P. Maxim; Influence of Range Finders, by Lieutenant Albert Gleaves; Notes on Three Guns Captured in Corea, by T. W. Clarke; and the usual variety of notes.

The High Tory or extreme British view of the United States is shown in a very savage article from *Blackwood's*, which is given in the ECLECTIC MAGAZINE for July. Human Electricity is an article from the *Fortnightly* in the same number, and there is altogether an interesting selection.

The July number of the ARENA is quite as bright and full of substance as usual. The leading article is on Mrs. French-Sheldon's explorations in Africa; another, which every one ought to read, is a discussion of the coming political campaign, in which each party's claim is given by its representative, the statements being as fair as could be expected from a thoroughly partisan standpoint.

The August number of the OVERLAND MONTHLY has a number of illustrated articles. Perhaps the most important of these is one on Fishing in Salt Water, treating the subject from a commercial standpoint, and showing the great extent of the industry and the varying methods followed in it. Other articles are on the Repeating Rifle and on Staging in the Redwoods, and there are also a number of sketches of less importance.

In HARPER'S MAGAZINE for August the last of the articles on the Danube is given. There are illustrated articles on Literary Paris; Corfu and the Ionian Sea; Ice and Ice-making; the Salzburg Exiles in Georgia, and a valuable paper on the Italian Army. The fiction in this number is of a varied character and generally good.

The military article in OUTING for July is by Lieutenant W. R. Hamilton, and treats of the Military Schools of the United States. An appreciative article by C. V. Vaux described the merits of the St. Lawrence Skiff, while the variety of articles on summer travel and sports is even greater than usual, as becomes a midsummer number.

In HARPER'S WEEKLY for July 23 there is an interesting illustrated article on Shipbuilding on the Great Lakes, containing much information on the importance and growth of that industry.

In the August number of the POPULAR SCIENCE MONTHLY the article in the Series of American Industries treats of the Boot and Shoe Manufacture. Mr. Carroll D. Wright treats on Families and Dwellings, the seventh of his Lessons from the Census. A paper by Professor Moss on Natural Selection and Crime requires careful study. An illustrated paper described the great Diamond Mining Industry which has grown up in South Africa.

BOOKS RECEIVED.

Proceedings of the Engineers' Club of Philadelphia: Volume IX, No. 3, July, 1892. Philadelphia; published by the Club.

Transactions of the Canadian Society of Civil Engineers: Volume V, Part II, October–December, 1891. Montreal; published by the Society.

Quarterly Report of the Bureau of Statistics, Treasury Department, on the Imports, Exports, Immigration and Navigation of the United States for the Three Months ending March 31, 1892. S. G. Brock, Chief of Bureau. Government Printing Office, Washington.

Twentieth Annual Report of the Board of Directors of the Pennsylvania Company; for the Year ending December 31, 1892. Philadelphia.

Census of Canada, 1891. *Bulletin No.* 10: *Manufactures. Bulletin No.* 11: *Nationalities.* Department of Agriculture, Ottawa.

Elements of Machine Design. Notes and Plates for the Use of Students in Lehigh University. By J. F. Klein, Professor of Mechanical Engineering. Bethlehem, Pa.; the Moravian Publishing House. We hope to give a careful review of this work in a later number.

Selected Papers of the Institution of Civil Engineers. London, England; published by the Institution. The present installment includes Bruce on the Rosario Water-Works; Wordingham on Meters for Electrical Energy; Binnie on Average Annual Rainfall; Bamber on Transverse Steel Sleepers; Douglas and Salmond on Lighthouses; Curtis on Gold Quartz Reduction; Abstracts of Papers in Foreign Transactions and Periodicals.

TRANSITION CURVES AGAIN.

To the Editor of The Railroad and Engineering Journal:

MY little rule for transition curves in the April number of the JOURNAL was simply devised to save carrying a number of tables into the field, and when used within the usual limits, as shown in the tables of Mr. Raymond and Professor Jameson, confining the curvature of the portion of the circular arc which is ameliorated to 20°, and the offset at *P C* to one-twentieth of the length of that arc, it works very satisfactorily and saves much time and trouble.

I am glad that Mr. Hughes called attention to this point, and will remind him that Mr. Raymond's curve, which I take to be the one he refers to, does not have the chord points "on a curve of a cubic parabola," and so escapes some of the troubles incident to cubic curves when used with great curvatures and offsets. JOHN F. WARD.

SOME CURRENT NOTES.

PERHAPS the most extraordinary work ever done by a lake carrier was by the steamer *Maryland*, which during the month of June carried away from Escanaba eight cargoes of iron ore, making in the aggregate 27,211 gross tons. The largest cargo was 3,507 tons, and the average 3,401 tons. The total amount of work thus done by the ship during the 30 days of June was the loading and unloading of these cargoes, and the running of 4,720 miles. The *Maryland* is a steel steamer built by the Detroit Dry Dock Company in 1890, and is, of course, equipped with all the latest appliances for speedy loading and unloading.

A NEW ship canal project has been brought forward by Professor Haupt, of Philadelphia, and others. The proposition is to widen and deepen the Delaware & Chesapeake Canal, which extends from the lower Delaware to the upper waters of Chesapeake Bay, so as to permit the passage of large ships. The canal is at present 14 miles long, 9 ft. deep and varies from 40 to 500 ft. in width on the surface. There is a tide-lock at each end and one other lock with a lift of 10 ft. It is now proposed to increase the depth to 25 ft. and to make the surface width not less than 170 ft. throughout, and to dispense with the middle lock, leaving only the tidal lock at each end. Owing to the nature of the land through which the canal passes this could be done at a comparatively small expense, the total cost being estimated at only about $2,000,000. The improvement would save some 200 miles in distance for large ships and steamers passing between Philadelphia and Baltimore, besides providing a line entirely inland.

THE block signals of the future were discussed by Mr. J. B. Stewart, who read a paper at the meeting of the Railroad Telegraph Superintendents at Denver. Mr. Stewart believes that the requirements of increasing traffic will be made by a combination of automatic and manual signals, the blocks to be comparatively short, with home signals operated by levers, and automatic signals worked either by electricity or air pressure placed, say, 1,000 or 1,500 ft. apart; the circuit connecting them to be also connected with the lever at the home station, so that when the home signal is placed at danger, the remaining signals throughout will also go to danger. Such an arrangement, he believes, would give ample protection for trains, while mistakes on the part of an operator may be prevented by different devices. One of the requisites of an electrical signal, to which sufficient attention has not been paid, is that all the instruments and batteries should be kept in good working condition and to receive frequent and systematic attention.

ANOTHER paper presented at the same Convention, by Mr. Charles Selden, calls attention to the possibilities of the electric motor in connection with ordinary railroad service. The writer does not believe that the electric motor will take the place of the steam locomotive for regular traffic, but thinks that it may be introduced to advantage for switching service, and to a considerable extent also for suburban service, where it would make possible more frequent trains, and better and more satisfactory service.

IN the near future the portraits that may be made of picturesque and historical Harper's Ferry, Md., will be very different from those now extant. The same mountains and rivers will be there, but the familiar railroad bridge will be taken away, and the entire works of the Baltimore & Ohio Railroad will be altered. The Company has awarded to Messrs. Jones & Thorne, of Baltimore, the contract for making this radical change. It will use up about $250,000 of the $300,000 appropriated for the alteration which will straighten the main line and throw out the awkward reverse curve which now exists on the bridge across the Potomac. It will also do away with the single track on the bridge and change the road radically along two miles of its length. The work of Messrs. Jones & Thorne includes a tunnel 875 ft. long through the

corner of Maryland Heights. From the point where the tunnel emerges they will build eight lofty piers of Gettysburg granite across and in the Potomac River, upon which will be constructed a stone bridge 700 ft. long. Its cost will be defrayed out of the remainder of the money appropriated. The work is to be completed in six months, in time for the World's Fair traffic, and from 600 to 800 workmen, including the quarrymen of the Gettysburg Granite Company, will be employed. The tunnel and the bridge will each be supplied with double tracks and the blocking of trains by the two present signal towers will be obviated. Upon the completion of the improvement a train, instead of curving off to cross the river, will enter the tunnel in the bluff 1,100 ft. east of the old bridge, and following a straight line, will emerge from the mountain-side about 200 ft. from the old bridge and about the same distance back from the river's northern bank and the Chesapeake & Ohio Canal. It will continue by a straight line directly across the canal and river upon the bridge, and strike the West Virginia side 100 ft. west of the old depot in the town of Harper's Ferry. On that side it will continue until it strikes the bluff along which the tracks are to be laid, on the solid mountain-side 400 ft. south of the present tracks. The trains following this course will strike the present tracks a mile above Harper's Ferry. This arrangement will do away with all the trestle work, about ¾ mile long, at Harper's Ferry. It will also straighten out every curve, and prevent many stoppages that occur because of the single track on the bridge. The Valley Branch, which connects with the main line on the West Virginia side, will also connect by a straight line near the West Virginia end of the new bridge instead of striking it by a curve. The contractors have already shipped several car loads of lumber and material to the point of operations, and they are hastening to get to work at the earliest possible moment. The plans for the bridge are under way. The old bridge was built at the close of the war to take the place of the one that was destroyed in course of the hostilities. The Baltimore & Ohio management had the recently adopted plans under consideration many years.

THE production of pig iron is decreasing slowly, the July report of the *American Manufacturer* showing 257 furnaces in blast with a total weekly capacity of 169,850 tons; a decrease of 3,040 tons, or 1¾ per cent., from the June report. As compared with July, 1891, there is but little difference, this year's statement showing an increase of only 2,426 tons, or 1½ per cent., in the weekly capacity of the furnaces in blast.

The total production of pig iron for the first half of 1892 is now estimated at 4,750,000 gross tons. No great changes are probable for a few months to come.

THE Consulting Engineer, Mr. J. B. Johnson, of St. Louis, to whom was committed the tests of the new water-works of the city of Peoria, has made a full report, from which the works seem to be a model plant for a city of moderate size. The tests consisted in an analysis of the water and a study of the geological formation from which it is drawn; an inspection of the pumping station and the machinery; a study of the plans and methods of construction of the reservoir and stand-pipes, and a study of the distribution and pipe system of the city. The water is pumped from a well into which it enters from the river, and a test made by pumping at the rate of 5,000,000 gallons in 24 hours reduced the level in the well only 3 ft. below that of the water. Pumping at double that rate (or 10,000,000 gallons) for seven hours reduced the level to 7½ ft. below the river, and other tests made showed that the water entered the well at a rate sufficient to raise its level about 1 ft. per minute. The test proved sufficiently that the supply through the well is more than equal to all the probable needs of the city for a number of years to come.

Chemical tests showed the water pure and wholesome, but slightly hard, as was to be expected from the nature of the surrounding country, which is almost entirely underlaid by limestone. The water from the river is filtered through nearly one-quarter of a mile of clean gravel before entering the well, so that it is extremely unlikely that any surface impurities should in any way enter it. A considerable part of the supply also comes from the gravel belt through which the well passes, intercepting the ground water-flow for a considerable distance.

The pumping works contain three sets of compound condensing Worthington high-duty pumps, each having two double-acting water plungers 21 in. in diameter. At normal speed these plungers work at the rate of about 140 ft. per minute and the capacity is 9,500,000 gallons in 24 hours. Steam is furnished by three batteries of Heine safety boilers, which are abundantly sufficient to supply the pumps. The machinery has been designed so that there can be no interruption of the regular supply for the city in the case of a break-down of one or even two of the pumps. It is housed in a substantial brick building.

The reservoir has a capacity of 18,000,000 gallons, or sufficient for several days' supply, even should the pumping machinery give out altogether. There are two stand-pipes having a capacity of 500,000 gallons each. Their summits are 320 ft. above the city datum, giving a sufficient head for all purposes.

The distributing system includes 75 miles of cast-iron pipe varying in size from the 30-in. mains leading from the reservoir down to 6-in. and 4-in. pipe.

These works were designed and constructed by the engineering firm of Moffatt, Hodgkins & Clarke, of Syracuse, N. Y., and form, as above stated, a very complete and substantial plant.

THE railroads of Japan, as might be expected from the broken and mountainous nature of the country, have required some expensive work in bridging and tunneling. The longest tunnel in the country is the Yanagase-Yama, on the Tsuruga line, which is 4,435 ft. in length. Four others are over 2,000 ft. long—the Osaka-Yama, 2,181 ft.; the Sekibe, 2,865 ft.; the Isohama, 3,167 ft., and the Makinohara, 3,273 ft. The Tokaido line has 26 tunnels, varying in length from 50 to 3,273 ft.

The longest bridge in Japan is the Tenriu-Gawa, which is 3,967 ft. long, and has 19 spans of 200 ft. each. The Oi-gawa bridge has 16 spans of 200 ft. each. There are no spans of over 200 ft. in the country.

THE Imperial Railroad of North China, which is the chief and in fact almost the only railroad in China, is now—as we have already noted—in charge of Mr. W. N. Pethick, who is an American and is familiar with American methods. Mr. Pethick has been taking such steps as have been in his power so far to introduce American methods, and it is understood that he has made arrangements to place a number of Americans in responsible positions on the road, believing that he can in this way much better meet the requirements of the country, and make the roads successful than by following the English practice, which controlled the first construction and for some time the management of the line. It is natural that this course should arouse opposition from some quarters, and it has been manifested in attempts to reverse his decisions, to depreciate his management and to restore to position some of the former managers. These have failed so far, however, and the present Manager has fortunately the entire confidence of the Viceroy, whose decision is final on all matters connected with the railroad. Upon the success of this line the future of railroads in China is very largely dependent.

THE last message to Congress of the President of the Argentine Republic refers to the Government guarantees of railroad dividends, and declares that there is now a large amount due from the guaranteed lines on account of payments made by the Government, which should have been repaid by the companies from their subsequent profits.

Immediate action to recover this money is recommended. Stricter execution of the laws for the supervision of the railroads is also promised. A number of concessions which had been made for new lines have been cancelled. The President reports that there are now in operation 7,675 miles of railroad in the Republic, of which

625 miles are owned by the State; 925 miles are owned by the different Provinces and 5,865 miles are owned by joint-stock companies. There are also 23 lines under construction, which when completed will add 3,175 miles to this total.

SOME reference has before been made to the investigation ordered by the New South Wales Parliament of the management of the railroad commissioners. One of the points especially to be investigated was the purchase of locomotives for the Government lines from the Baldwin Works in Philadelphia. This was one of the points most strongly urged by the opposition in Parliament, and to some extent this revealed the true animus of the investigation, the purchase of these Baldwin engines having been a very sore point with a certain party in Australia. Political motives, it is understood, were also mixed up in the investigation, which has so far revealed nothing whatever to the discredit of the Commissioners, but, on the contrary, has served to vindicate their management. As to the Baldwin engines, the fact that when they first went into service there was some trouble with broken axles has been made the most of, but it seems that the defective axles were made good by the Company, and that the engines have done very satisfactory work.

NOT much progress is apparent in the various projects for bridges across the Hudson and East Rivers to connect the city of New York with the opposite shores. That there is an urgent need for two more bridges over the East River to connect the city with Long Island, and for at least one and probably two bridges over the Hudson, is generally admitted, but lack of capital, some interested local opposition, and to some extent jealousy and dissension among the advocates of different plans seem for the present to have blocked all progress.

THE New York Rapid Transit plan has advanced another step, the Supreme Court having approved the report of the Commissioners, and the plans submitted for an underground line from the Battery to the northern limits of the city, the details of which have been previously explained. The legal obstacles are now all passed, and the next thing to be done is for the Commission to offer the franchise for constructing the road to that corporation or combination which is willing to undertake it on the most favorable terms for the city.

A COMPOUND FAST PASSENGER LOCOMOTIVE.

IN the JOURNAL for January, 1892, there was published a brief note on the performance of a compound locomotive especially designed for fast passenger service with heavy trains, by M. du Bousquet, Chief Engineer of Material and Traction of the Northern Railroad of France. This engine is a machine of exceptional interest, and in many respects of excellent design. We have received from M. du Bousquet a copy of a paper on this engine and its performance, which was prepared by him for the *Revue Generale des Chemins de Fer*, a condensation of which, it is believed, will present some interesting points. The illustrations herewith show a general view of the engine; a longitudinal section and half plan; two cross sections showing respectively the high and low-pressure cylinders; and an enlarged view of the valve by which the high-pressure exhaust can be turned directly into the smoke-box. The copy from which the illustrations were prepared was, unfortunately, somewhat imperfect, and time did not permit new drawings to be secured; but the general features, it is believed, are sufficiently shown.

The general design of the engine follows the American type of four coupled driving-wheels and a four-wheeled truck, the peculiarities being in the arrangement and connection of the cylinders. It is a four-cylinder compound, having two high-pressure and two low-pressure cylinders connected through an intermediate reservoir. The two high-pressure cylinders are placed outside and immediately in front of the forward drivers; their connecting-rods extend to the outside crank-pins of the rear pair of drivers. The low-pressure cylinders are inside, in the smoke-box, and are connected with cranks on the forward driving axle. The driving-wheels are coupled by parallel rods outside in the ordinary way. This arrangement was adopted after careful consideration and as a result of experience with a four-cylinder compound engine built some time before. The driving-axles are placed, one in front of the fire-box and the other behind it.

It may be noted that the cranks of the high and low-pressure cylinders are not at an angle of 180°, but at 162° —an arrangement adopted to assist the engine in starting.

The locomotives--there are two of them now in service —were built for the Northern Railroad by the Société Alsacienne de Constructions Mecaniques, and have now been at work about seven months.

The boiler is built for a working pressure of 190 to 200 lbs. The barrel is 49.8 in. in diameter inside the smallest ring, and has 202 tubes 1.77 in. in diameter and 12.8 ft. long. The fire-box is 58 in. in depth at the back end and 68 in. at the front; the grate area is 21.96 sq. ft. There is a deflector or water-leg of a kind much in use on the Northern Railroad, and known as the Tenbrink deflector. The heating surface is: Fire-box—including deflector—146.7 sq. ft.; tubes, 1,054.87 sq. ft.; total, 1,200.94 sq. ft. The fuel generally used is bituminous coal mixed with briquettes of compressed fuel, which are much used in France.

The truck has a plate frame and outside journal bearings; the springs are not equalized. The wheels are 40.9 in. in diameter, and the axles are spaced 4 ft. 11 in. between centers.

The driving-wheels are 83.2 in. in diameter, and the driving-axles are 9 84 ft. between centers. The distance from the rear driving-axle to the center of the truck is 21 ft. 11 in. The crank-axle for the forward drivers is of the Worsdell type, with circular jaws.

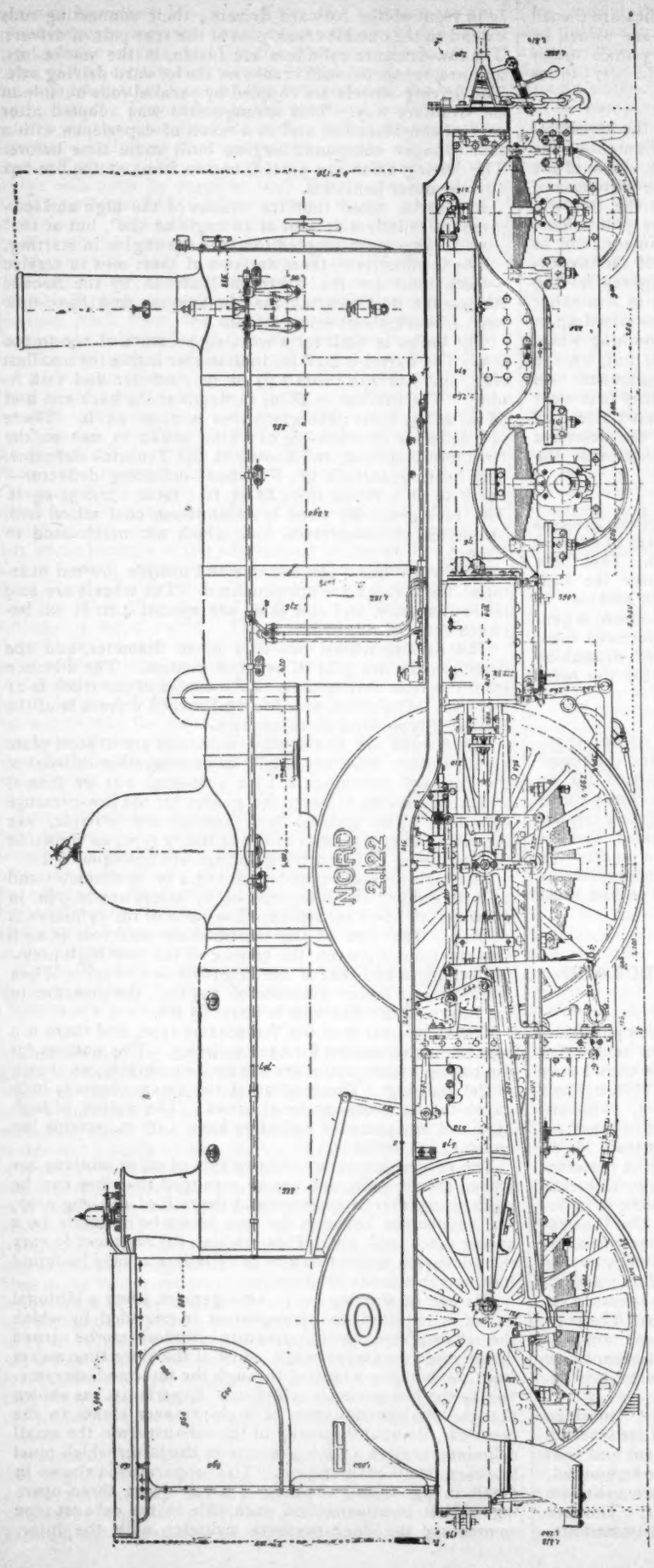
The frames are of the plate type, and are of steel plate 1.1 in. thick. They are solidly braced together in front of the forward driving-axle by a cast-steel box or frame, which also serves to carry the guides for the low-pressure cylinders. The guides, both inside and outside, are double, with cross-heads of the ordinary type, as shown in the engraving. The driving-springs are not equalized.

The high-pressure cylinders are 13.4 in. in diameter and 25.2 in. stroke; the low-pressure cylinders are 20.9 in. in diameter and 25.2 in. stroke. The ratio of the cylinders is 1 : 2.42. The size of the intermediate reservoir is such that the ratio between the volume of the two high-pressure cylinders and that of the reservoir is 1 : 1.36. When working at a boiler pressure of 195 lbs., the pressure in the intermediate reservoir is about 85 lbs.

The valve gear is of the Walschaert type, and there is a separate valve motion for each cylinder. The motions for the high-pressure cylinders are entirely outside, as shown in the drawing. The position of the steam-chests is indicated in the cross-sectional views. The valves of both high and low-pressure cylinders have 1.07 in. outside lap and 0.12 in. inside lap.

The reverse levers for the two sets of valve motions are placed side by side, and are so arranged that they can be worked together or separately at the will of the engineer, the connection between the two levers being made by a spring catch and pin. This enables the engineer to vary the admission to the two sets of cylinders as may be found most advantageous in practice.

For use in starting or in emergencies when additional power is required, an arrangement is provided by which the exhaust from the high-pressure cylinders can be turned directly into the smoke-stack, while at the same time steam from the boiler is admitted through the intermediate reservoir to the low-pressure cylinders. Experience has shown that the simple admission of high-pressure steam to the reservoir, without disposing of the exhaust from the small cylinders, creates a back-pressure in the latter which must be taken into consideration. This apparatus is shown in detail in fig. 6, and consists of a valve with three openings which is attached on each side to the exhaust-pipe connecting the high-pressure cylinder with the inter-



FOUR-CYLINDER COMPOUND LOCOMOTIVE, NORTHERN RAILROAD OF FRANCE.

mediate reservoir. The exhaust-pipe enters a cast-iron box, *A*, the connection being made by an expansion-joint and stuffing-box, *C*. The cylindrical valve *B*, according to its position, permits the exhaust steam to continue directly forward on its way to the reservoir and the low-pressure cylinders, or turns it into the pipe *T*, which leads to the smoke-box. When the valve is placed as shown in the engraving, the high-pressure exhaust thus passes directly to the smoke-stack. A quarter turn of the valve *B* is sufficient to make the change. Motion is given to the valve by the rod or stem *t*, which passes through a stuffing-box *L*. As the working of this valve from the cab by rods and levers would require a somewhat complicated arrangement, it is operated by a small steam cylinder, the piston-rod of which is connected to a lever keyed on the valve-rod *t*. Steam is admitted to this cylinder from the boiler by opening a small valve, and the whole arrangement is a very simple one.

The total weight of this engine ready for service is 105,350 lbs., of which 38,130 lbs. are carried on the truck, 33,830 lbs. on the forward drivers and 33,390 lbs. on the rear drivers; the total weight on the drivers, which is utilized for adhesion, is thus 67,220 lbs.

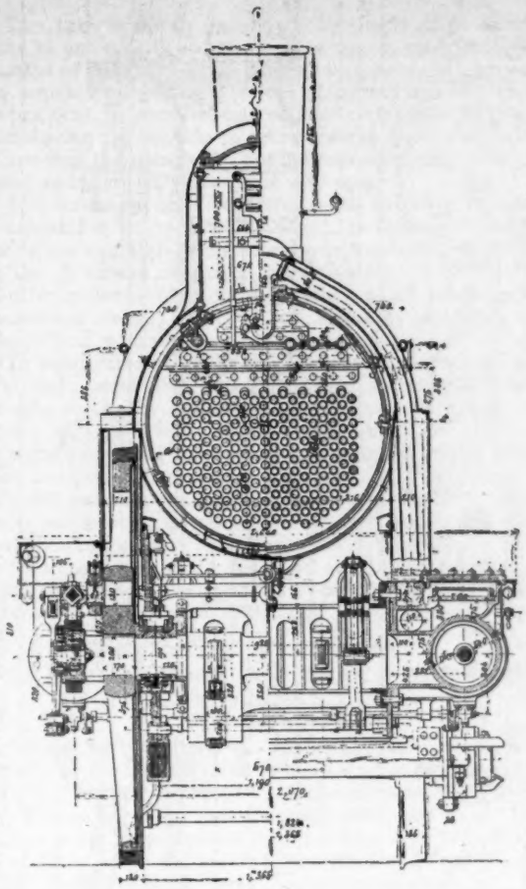
The tender is carried on six wheels of 49.1 in. in diameter. It will carry 3,900 galls. of water and 8,800 lbs. of coal. The total weight with a full load of coal and water is 74,050 lbs.

The total wheel-base of the engine and tender together is 43.8 ft., and their total length outside of the drawheads is 53.9 ft.

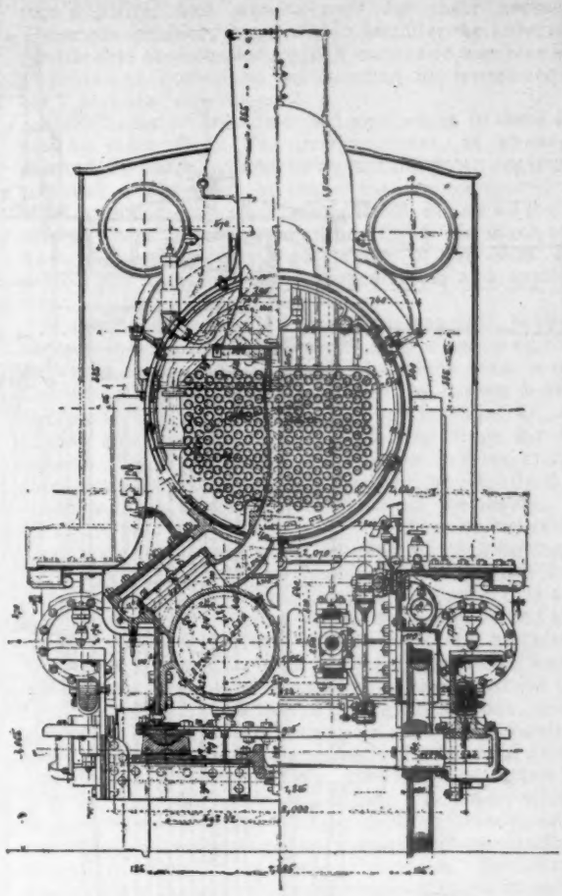
In service these engines have been employed on the fast express trains between Paris, Amiens and Lille, where a high speed is required, with trains varying in weight from 110 to 200 tons, exclusive of the weight of engine and tender. The average speed of these trains is from 45 to 50 miles an hour. With a train of 140 tons, one of them has made the run from Paris to Amiens, 81 miles, in 90 minutes, or at the rate of 54 miles an hour; and with a train of 200 tons it has made the run from Paris to St. Quentin, 95 miles, in two hours, or at the rate of 47½ miles an hour. In their regular work they are frequently called on for exceptional speed where it is necessary to make up time on account of delays on connecting lines or other causes.

Among these exceptional performances are included a run at the rate of 43 5 miles an hour up a long grade of 0 8 per cent., the train weighing 140 tons, or 220 tons with engine and tender; a run at 46.6 miles an hour up a grade of 0.5 per cent., with a train of 225 tons, or 305 tons, including engine and tender; a run at 55 9 miles an hour on a level with a train of 210 tons —290 tons, including engine and tender.

Among the excellent points shown by these engines have been quickness in starting and in reaching full speed from a stop; great stability at high speeds, and an economy in fuel as compared with other engines doing the same work.



SECTIONS SHOWING HIGH-PRESSURE CYLINDERS.



SECTIONS SHOWING LOW-PRESSURE CYLINDERS.

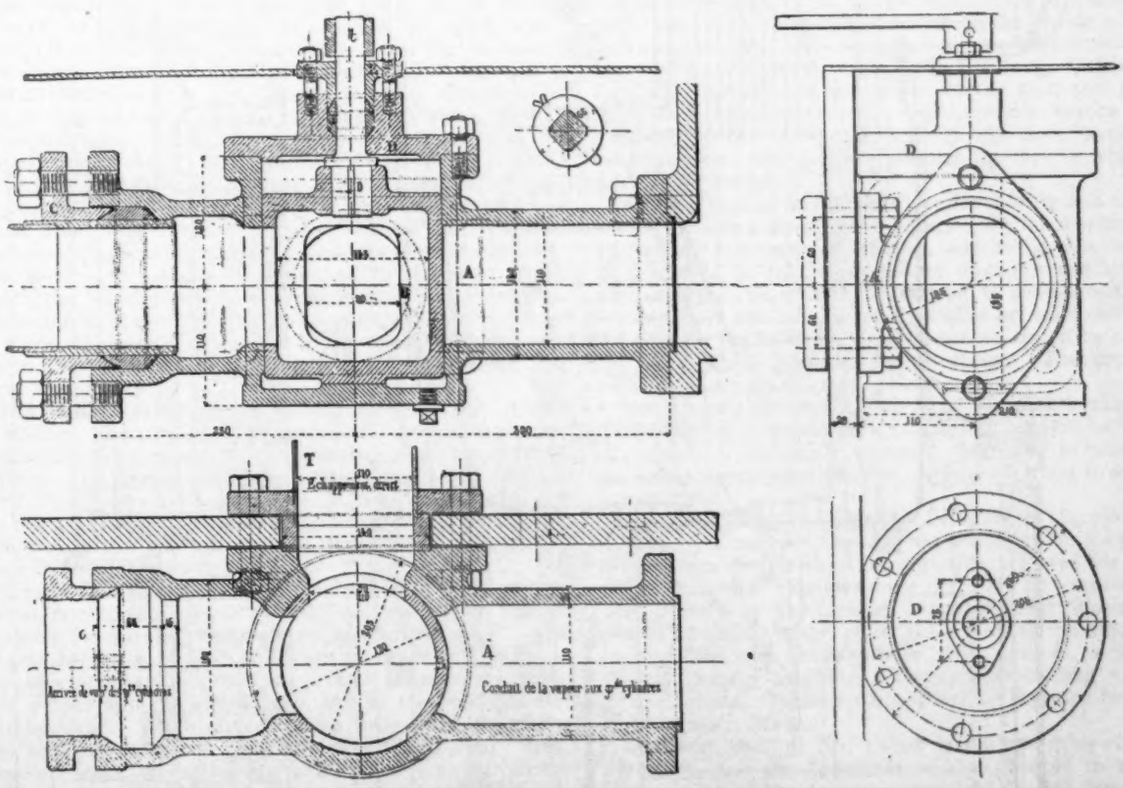


Fig. 6.

Fig 1 Coupe longitudinale

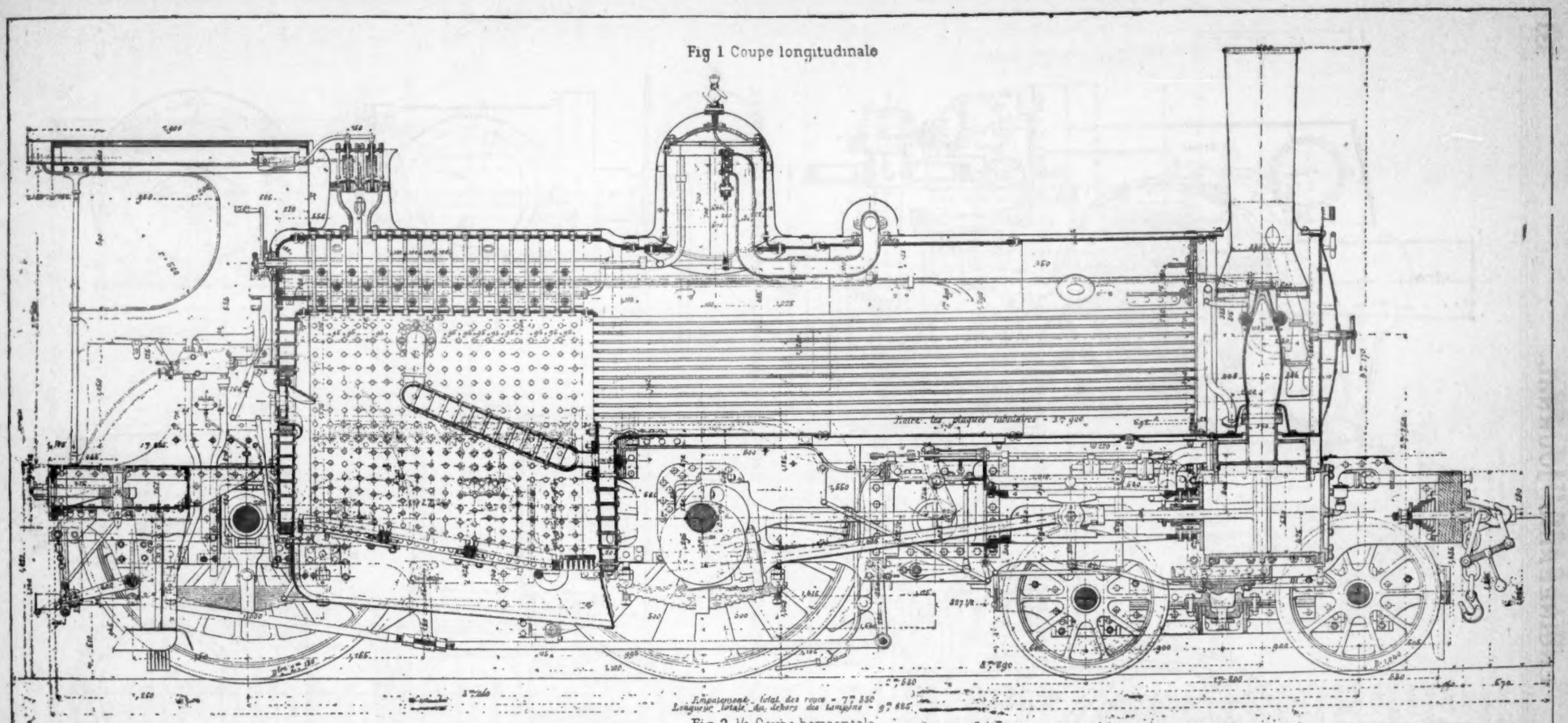


Fig. 2. 1/2 Coupe horizontale

FOUR-CYLINDER COMPOUND LOCOMOTIVE FOR PASSENGER SERVICE, NORTHERN RAILROAD OF FRANCE.

The fuel economy as shown by single trips has been over 23 per cent.; as shown by a much safer test—three months of regular work—it was 14.45 per cent. An economy which would hardly be looked for was a saving of some 10 per cent. in consumption of lubricating oil. It is stated that during the months of service every means were taken to see that the compound engines received only fair treatment and were not favored in any way.

The maximum tractive power when working compound is calculated at 17,295 lbs., which is increased to 22,040 lbs. when the high-pressure cylinders exhaust directly and all the cylinders are working separately. The maximum tractive power obtained in practice when working compound has been 11,174 lbs., or about 65 per cent. of the theoretical maximum.

To meet certain criticisms this engine was tried for several days with the parallel rods removed, so that the drivers were not coupled. The results were not favorable. While the same speed was attained, the engine lost in some degree its quickness in starting, and some slipping was noticed while running as well as in starting. The exhaust was not as even, and there was some irregularity in its pulsations; it was also less quiet, and it was evident that the engine worked better when coupled.

This engine of M. du Bousquet is in many respects a remarkable locomotive, and deserves careful attention. As a whole it certainly reflects credit on the designer.

THE NEW YORK AIR-BRAKE COMPANY'S WORKS.

As the early patents on air-brakes have nearly all expired, the business is now open to any one disposed to go into it. In the early days of their evolution Mr. Frederick W. Eames invented and manufactured a form of vacuum brake which was known by his name, and which is still used on some roads, among them the New York Elevated.

He established his manufactory at Watertown, N. Y. As some of our readers may have only an indefinite idea of the location of this place, it may be explained that it is in the northern part of the State, only a few miles east of the eastern end of Lake Ontario. It is located on Black River, which supplies a magnificent water power at this point to the brake works, and to a number of large paper-mills. The river has its headwaters about the middle of that portion of the State which is north of the New York Central Railroad. It flows northwestward and empties into the eastern end of Lake Ontario near Sackett's Harbor of historic fame. Watertown is one of the most beautiful places in the State. The dwelling-houses of the well-to-do people—of whom there seem to be a great many—are of exquisite design, and generally have ample grounds about them. The streets are well shaded, and with the yards and gardens form perfect pictures of sylvan beauty. The works are located on an island in the river about which the water tumbles and whirls in a way that is bewildering to a stranger, but fascinating, too, to a driver of a pen or pencil whose daily life is spent in the haunts which are known as "up-town" and "down-town" in New York City.

The works are under the management of Mr. Albert P. Massey, Mechanical Engineer; R. C. Augur, Assistant Mechanical Engineer; H. G. Manning, Superintendent; William H. Pollard, Assistant Superintendent; W. H. Ford, Chief Draftsman; and J. E. Stebbins, Specialist, the meaning of which latter title is that any special work which does not come under the jurisdiction of other departments is referred to him.

A plan of the works is shown by the diagram herewith. About 600 hands are employed, and the shops have a capacity for turning out a large amount of work. The largest of the group of buildings is the machine shop, which is built of brick, 41′ × 250′ and three stories high. The offices and drawing-rooms are in the south end of this building. The different shops have in all six elevators built by Morse & Williams of Philadelphia. With these all work is carried up and down to and from the different floors. All the shops are models of cleanliness, and ample provision is made for washing, closets for the men's attire, and water-closets for their necessities. These conveniences recall with a shudder the horrors and unutterable abominations which existed in machine shops 40 years ago, during the period when the writer acquired his "practical experience."

Some notes of the tools and appliances in these shops may be interesting. The driving power, as already remarked, is water, which, being unfailing, no engines are required. The parts of brake fixtures, compared with ordinary locomotive work, being small, nearly all the tools used in these shops are small and light. In much of the work, however, a very high degree of precision is required, and therefore the very best tools and appliances must be used.

In the machine shop there are, for example, such tools as the following: Seven Brown & Sharpe screw machines, on which brass work for valves of various kinds is done; six milling machines, some of them by Brown & Sharpe and some by Warner & Swasey, of Cleveland, O., and a milling machine for grinding packing rings for triple valves. These rings are made eccentric in form, and their sides must be ground so that they will be slightly thicker on their outer edges than they are on the inside. This requires very accurate work. Wet emery-wheels are used for grinding tools. A number of cock-boring and key-turning machines by Warner & Swasey are in use. Some of these have double heads arranged so that a cock may be bored with one of them, and a key turned simultaneously with the other. A monitor turret machine, by Warner & Swasey, is used for doing the lathe work on the main triple valves. Two three-spindle sensitive drills, by Dwight Slate Machine Co. of Hartford, Conn., are employed for drilling the minute holes which are required in some parts of the brake apparatus. Two special grinding machines, by Brown & Sharpe, used for grinding the cylinders for triple valves are interesting. The emery-wheel, of course, revolves rapidly and the cylinder slowly. At the same time the emery-wheel has a movement longitudinal to the cylinder equal to the stroke of its piston. By this means the insides of the cylinders are finished with the utmost precision. As this part of the brake apparatus is very delicate, the pistons, cylinders and valves must all be finished in the most exact way.

The valve-seats in the triple valve consist of a slot $\frac{7}{16}$ in. wide and $\frac{3}{16}$ in. deep, which is cut on the inside of a cylindrical surface. This is done by a machine which has a spindle $1\frac{1}{8}$ in. diameter and about 5 ft. long, with cutters on the under side of the width of the slot, and shaped somewhat like saw teeth. This spindle moves longitudinally to the valve-case, and in less time than it has taken to write this description cuts the slot in which the slide-valve works.

Another special machine is one for boring and tapping cocks. It has a three-jawed chuck, which holds one cock for boring and one for tapping, and while this is being done a cock is taken out of the third jaw and replaced with another, so that the operation is continuous. The boring tools are held in two spindles on each end which are thrown out by cams. Cocks are all tested by subjecting them to air-pressure below water. The escape of bubbles of air reveals any leakage.

No. 3 shop is devoted chiefly to vacuum brake work. This form of brake is still extensively used as an engine brake and on the cars of elevated railroads, in cities, and on foreign lines where it was introduced when it was first brought out.

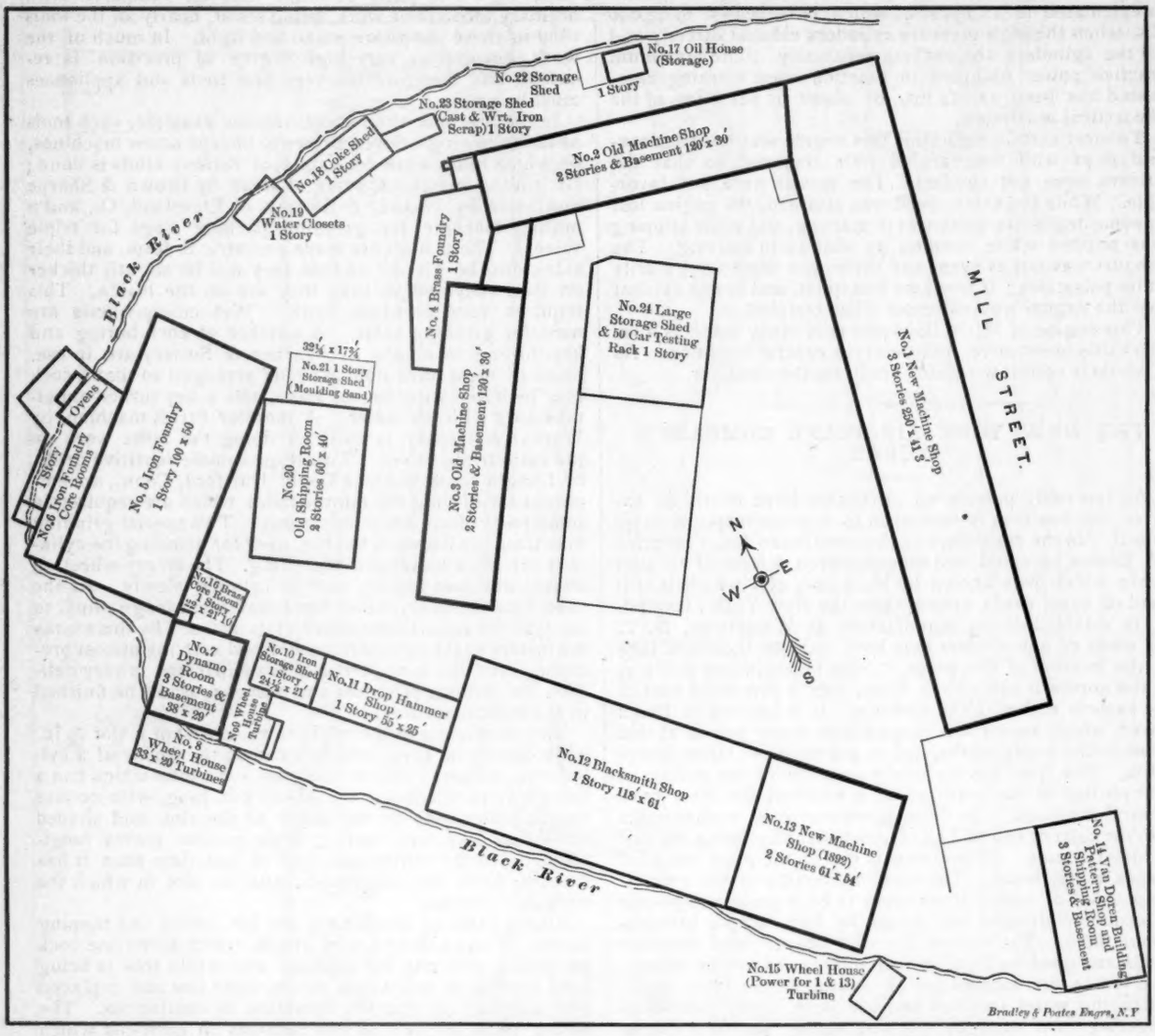
A 36-in. boring-mill, by the Bridgeport Machine Tool Company, is used for finishing the center plates for pumps. Two Sellers double-shaft boring-mills are used for boring pump cylinders. Besides these there are 10 single-spindle boring mills, by the Newton Machine Tool Works, employed in boring brake cylinders. Among the other tools in use are two three-spindle drill presses, one four-spindle tapping machine, a two-spindle drilling and tapping machine. These machines are by Prentice Brothers, of Worcester, Mass.

The first floor of No. 3 shop is the assembly-room for air work, and the basement is also devoted to vacuum work. One of the processes required in this department is to saturate the cylinders and diaphragm cases in hot

paraffine to make them air-tight, as it is found that air will often leak through ordinary castings.

The tool-room is on the first floor of No. 1 shop. It is supplied with a No. 1 Brown & Sharpe universal grinding machine, two No. 3 universal cutter and reamer grinding machines, a twist drill grinder, made at the Worcester Institute of Technology, and all the other tools usually found in such departments.

one of the air-pistons in the usual way. The contents of the two air-cylinders are compressed into the smaller cylinder, and then the contents of the smaller cylinder are compressed into the reservoir. The action of the pump in compressing air is thus similar to that of using steam in a compound engine, and results in a corresponding economy. These pumps when they are completed are tested under steam for a given period, and, while working


No.17 Oil House (Storage)
No.22 Storage Shed 1 Story
No.23 Storage Shed (Cast & Wrt. Iron Scrap) 1 Story
No.18 Coke Shed 1 Story
No.19 Water Closets 1 Story
No.2 Old Machine Shop 2 Stories & Basement 120' x 30'
Black River
No. 4 Brass Foundry 1 Story
No.24 Large Storage Shed & 50 Car Testing Rack 1 Story
MILL STREET.
No.1 New Machine Shop 3 Stories 250' x 41' 3"
No.21 1 Story Storage Shed (Moulding Sand)
Ovens
No.6 Iron Foundry Core Rooms 1 Story
No. 5 Iron Foundry 1 Story 100 x 60
No.20 Old Shipping Room 2 Stories 60' x 40'
No.3 Old Machine Shop 2 Stories & Basement 120' x 30'
N
W
E
S
No.16 Brass Core Room 1 Story
No.7 Dynamo Room 3 Stories & Basement 38' x 29'
No.10 Iron Storage Shed 1 Story
No.11 Drop Hammer Shop 1 Story 55' x 25'
No.9 Wheel House Turbines
No. 8 Wheel House 39' x 29' Turbines
No.12 Blacksmith Shop 1 Story 118' x 61'
No.13 New Machine Shop (1892) 2 Stories 61' x 54'
No. 14 Van Dorn Building Pattern Shop and Shipping Room 3 Stories & Basement
Black River
No.15 Wheel House (Power for 1 & 13) Turbine
Bradley & Pontes Engrs, N.Y.

PLAN OF NEW YORK AIR BRAKE COMPANY'S WORKS, WATERTOWN, N. Y.

Ample iron and brass foundries and a blacksmith shop are also part of this establishment. In the latter considerable heavy work must be done for heavy locomotive brakes. A peculiarity in the blacksmith shop is working the power hammers with compressed air instead of steam. This air is compressed by water power.

In the manufacture of brake apparatus the utmost care must be taken in the inspection of it during the time it is being manufactured, and after it is completed. A defect in any part of the apparatus may, after it is put in service, mean failure, and failure may mean disaster. Therefore at every stage of the work the most rigid inspection is applied to all the parts which are turned out.

What is called a "Duplex" air-pump is used by the New York Air-Brake Company for compressing the air which operates the brakes. It has two steam and two air-cylinders. The two steam-cylinders are of the same size, and are placed side by side. The air-cylinders are of unequal size. Each of the steam-pistons is connected to

with a required steam pressure, they must make a specified number of strokes against the pressure of air under which the brakes are worked.

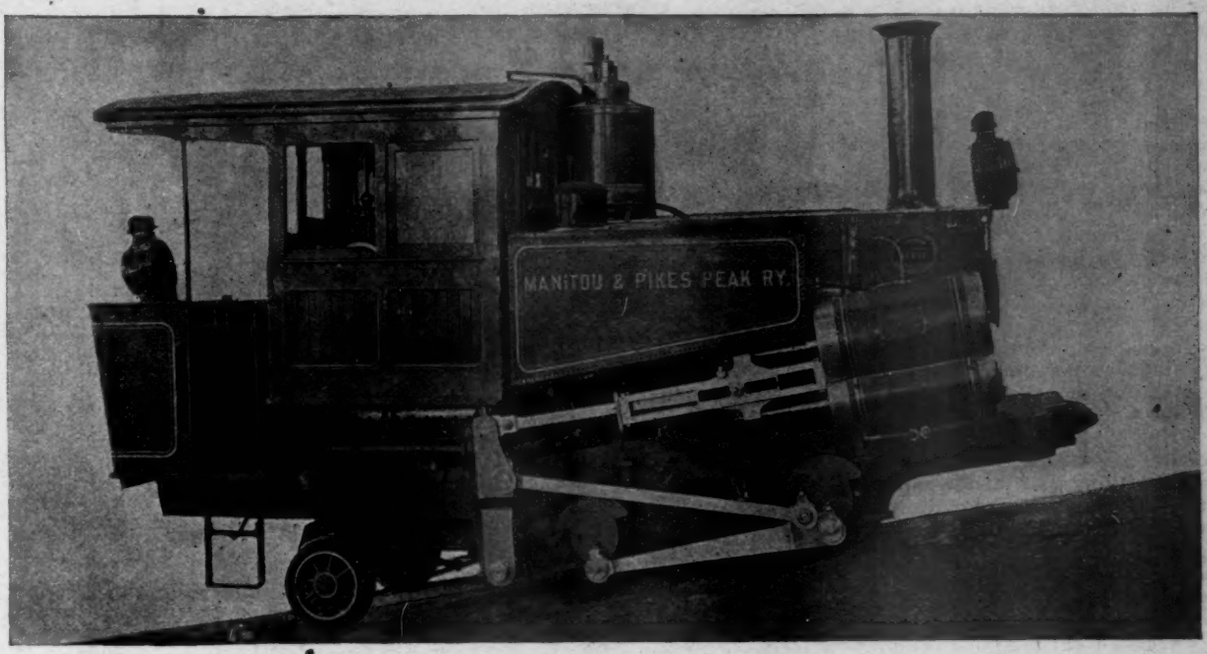
The engineer's valves are tested on a rack which has all the apparatus and piping for 10 cars, and all the fixtures on the cars are tested on another rack which has the same length of piping and will receive all the apparatus for 50 cars. These are tested under air pressure in one direction and it is then reversed—that is, the pressure is applied so that the first apparatus becomes the last and the last first. Any defect or failure to work properly is thus detected, and of course remedied at once. When it is all perfected and completed it is brought to shop No. 14 for packing. Before this is done it is taken to the inspection-room in this same building for a final inspection. The pattern, stock, and storage-room are in this same building.

The extent of this establishment and the perfection and capacity of its equipment was a surprise to the writer, as he believes it will be to many of his readers.

A COMPOUND RACK-RAIL LOCOMOTIVE.

THE illustration here given is from a photograph of a locomotive of the Vauclain four-cylinder compound type built for the rack-rail road up Pike's Peak. The engine is carried on six wheels running on the ordinary rails, and the power is applied to toothed drivers which engage with the rack-rail. The connecting-rod works on a lever, the lower end of which is pivoted on the frame, and a second connecting-rod extends from a pin on this lever to an outside crank on the forward driving-axle. The whole arrangement is very clearly shown in the photograph, with the exception of the driving-wheels, which are concealed by the frame.

The boiler is set at an angle of about 10° with the track, in order to keep it nearly horizontal. The frames are outside, and are of the plate type. The rear pair of bearing-wheels are arranged in a two-wheeled truck.



COMPOUND LOCOMOTIVE FOR A RACK-RAIL ROAD.

The boiler barrel is 46½ in. in diameter, and has 158 tubes 1¼ in. in diameter and 7 ft. 3 in. long. The fire-box is 36¾ in. long and 51⅝ in. wide, the outside frames permitting this unusual width. Water is carried in two side tanks, each holding 200 gallons. The coal-box is at the rear end of the cab. The total wheel base of the bearing-wheels is 11 ft. ⅛ in. The total weight of the engine in working order is 45,850 lbs., of which 33,200 lbs. are carried on the drivers.

The high-pressure cylinders are 9 in. in diameter and the low-pressure 15 in., both being 22 in. stroke. The valve gear is that ordinarily used in the Vauclain engine. The ratio of the cylinders is 1 : 2.78. The driving-axles are spaced 4 ft. 9⅝ in. between centers; the toothed driving-wheels are 22.468 in. in diameter, measured on the pitch line. The gauge of the bearing rails is the standard, 4 ft. 8½ in.

The engine is a neat and compact design and well adapted for its special work. An excellent feature is the adoption of the outside plate frame, giving fire-box room which could not otherwise be obtained without lengthening the boiler to an undesirable degree.

THE BHATGARH DAM.

FOR some years past English engineers have been engaged upon extensive works by which the waters of the Nira River, in India, are preserved and utilized for irrigation. In connection with these works it was found advisable to provide a large storage reservoir, and the spot selected was at Bhatgarh, where the Yelwandi River joins the Nira. The tributary stream brings down a large amount of water in the rainy season, and its valley above the junction is well adapted for a reservoir. The dam as planned and built is across the Yelwandi, just above its mouth, and is a work of considerable magnitude. For the description of the dam and the accompanying drawing we are indebted to the *Indian Engineer*.

The dam, which is of masonry and concrete, is 3,020 ft. long, with a maximum height of 127 ft. above lowest foundation and 103 ft. above the bed of the river, the width at full supply level being 12½ ft., and the maximum width at base 76 ft. Two waste weirs are provided, one at the south and one at the north end of the dam. A roadway with clear width of 11 ft. is constructed on the top of the dam and carried over the waste weirs by means of piers and arches. The combined length of the dam and weirs is 4,067 ft., the clear length of water way on the two weirs being 810 ft., calculated to discharge the maximum flood with a head of 8 ft.

Fifteen under-sluices are built in the dam, in the river portion, each 8 ft. × 4 ft., with their sills 12½ ft. above the bed of the river, and designed to carry off the early monsoon floods, which are heavily laden with silt. Two additional sluices to draw off the water at higher levels for the canal supply are built, one in the north and the other in the south flank, each 3 ft. × 3 ft., with their sills respectively 24 and 50 ft. above the sills of the under-sluices.

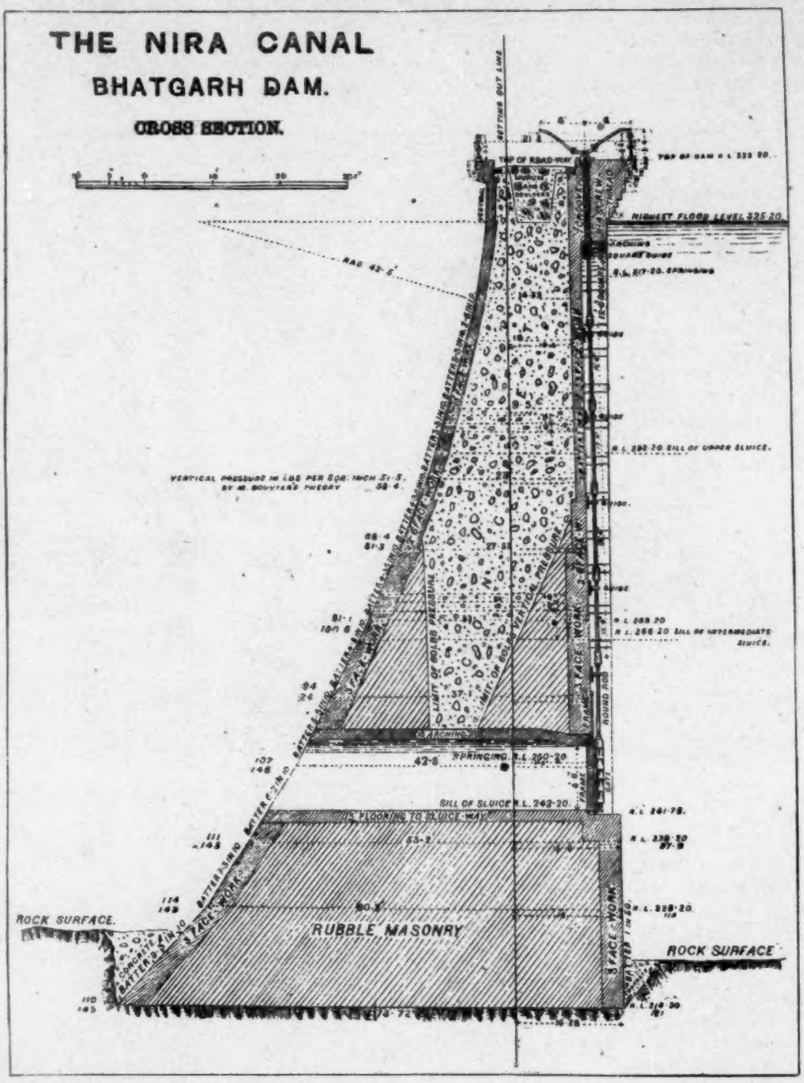
Seven turbine sluices, two on the right and five on the left bank, have also been provided, each 2½ ft. diameter.

The line of the dam crosses the river in a curve of 4,500 ft. radius convex to the water, the length of the curve being 2,300 ft.; it is continued on the north bank, in a line tangential to the curve, and on the south a reverse curve of 300 ft. radius for a length of 407 ft. brings the line to the ridge along which it is taken in a straight line tangential to the last curve, the length of 400 ft. at the south end giving an excellent site for a waste weir. The curved plan of the dam was adopted to suit the best line of foundation and not with any idea of giving additional strength. This form, however, adds considerably to the beauty of the structure, and gives an appearance of greater strength. A light railing 3 ft. high is provided on each side of the roadway along the top of the dam. It consists of cast-iron standards fixed in the parapets 10 ft. apart, and supporting a double line of wrought-iron piping.

In the original design the section was calculated for a maximum height of 101 ft. with top width of 13.65 ft., bottom width, 67.64 ft., and the down stream profile in three straight batters. The dam was to be of rubble masonry, the weight of which was assumed in the calculation at 140 lbs. per cubic foot.

In 1883 the design was revised, and the conditions laid down were that the intensity of vertical pressure was to be nowhere more than 120 lbs. per sq. in. ; that the resultant pressure was to fall within the middle third of the base of any portion of the section, and that the average weight of the material (rubble masonry and concrete) was to be taken at 160 lbs. per cubic foot. This weight was decided upon after a number of experiments with samples of the materials that it was proposed to use.

The water face of the dam which has been built has a batter of 1 in 50 and the profile of the down-stream face is a series of straight batters for every 10 ft. height, the general curve being a catenary. While the curve was adopted for the face of the dam, in practice it was found easier to build according to the designed straight batter and to check the width from a fixed setting-out line ; the general appearance is a curve, as it is difficult to detect where the changes of batters occur. As a matter of curiosity, the profile has been checked by means of a chain, and it was found to correspond generally to the catenary, but this method could not be used with accuracy for building purposes. Looking at the section illustrated, it will be seen that on the up-stream side, at the sill level of the sluices, an increased width of 4 ft. is provided. This is to take the piers between the sluices to carry the lifting gear at the top of the dam, also to give room for the protective screens, and to provide a pathway to give access to the front of the sluices. The fact that the introduction of the openings for the under-sluices would intensify the pressure in the section between them also rendered an additional width advisable, and this was taken into consideration in the calculations. The section was worked out for a height of dam of 103 ft. ; in those places in the river, where the extra depth of foundations produced a slightly greater height than this, the last batter, 9.3 in 10 was continued, and the first few courses at foundation level were laid somewhat in excess of the calculated width. The maximum pressure, 117 lbs. per sq. in., occurs at up-stream toe, reservoir empty. In this diagram two sets of figures are shown for the intensity of pressure at the down-stream edge of each sections. The upper figures on it are the results of the calculation by the ordinary method, and the lower denote the corresponding results arrived at by Bouvier's theory, the latter being considerably in excess of the former. The mortar used in the work is known to have a crushing strength, when one year old, of fully 700 lbs. on the sq. in. ; therefore the factor of safety in the case of both calculations is very large.



The final sanctioned section for the Bhatgarh Dam was designed, and all the calculations worked out by Mr. A. Hill, Assistant Engineer, under the orders of Mr. Whiting, the Executive Engineer.

The site selected was, in the first place, opened out as much as practicable along the whole length, so as to ascertain that sound rock was available everywhere, special caution being necessary in the river crossing, where there would be a heavy overfall from the under-sluices. The trial trenches which were carried deep into the rock in the river bed discovered the existence of a layer of basalt, about 12 ft. thick, overlying the trap and separated from it by a thin film of yellow clay. The rock itself was perfectly sound and of a most durable character, but as it was jointed and had not an even bearing on the rock below, it was decided to remove the whole of it. The quantity that had to be excavated was greater than anticipated, and in one place sound rock was only reached at a depth of 26 ft., giving a width of foundation of 74 ft. Close to the right bank of the river, the rock was found to exist in large cubes, separated from each other by joints of soft clay of varying thicknesses. Although the rock itself was of an excellent quality, the whole of the jointed mass was removed until perfectly sound rock was obtained for the full width of the foundation, which occurred at a depth of 50 ft. The founds were stepped up toward the south, and good rock was met with until close to the junction of the small reverse curve with the main curve of the dam, where it dropped suddenly and was replaced by a soft red rock. This had to be excavated for a depth of 30 ft. before a reliable foundation could be obtained ; from this point to the end sound rock was found comparatively close to the surface. In the original design it was proposed to construct only one waste weir on the south bank, the length extending to the small reverse curve above referred to. The existence, however, of the soft red rock in this portion, where the overfall would have been very great, necessitated an alteration in the design, which has proved to be also a great improvement. The south weir was shortened so as to confine the overfall to the length where the founda-

tion was good, and a second waste weir was designed at the north end of the dam, where excellent rock existed. Increased waste weir accommodation was thus obtained, and it was possible to provide the full required number of automatic sluice gates on the north weir that would have been impracticable on the south.

No difficulty was experienced in obtaining good foundation on the left bank, except at one point in the site of the north waste weir, where the rock was much fissured. It was, therefore, decided to build up the waste weir at this point for a distance of 50 ft., to prevent any overfall on the rock that appeared to be not sufficiently sound to resist it. The dam, therefore, has been founded throughout on a rock base, about the strength and soundness of which there can be absolutely no doubt. Before commencing work, every foot of the foundation was carefully tested, and in most cases holes were drilled into the rock 3 or 4 ft. in depth, to be certain of its soundness. All levels and other information has been recorded on a foundation plan.

In the original design, it was proposed to construct the dam entirely of rubble masonry. The excellent results, however, obtained from experiments with sample of concrete used in the main weir at Vir, resulted in the substitution of concrete for rubble masonry in the hearting of the dam, with the object of reducing the cost of construction. The result of a series of experiments with blocks of concrete at Vir showed that the average crushing weight was 400 lbs. on the sq. in., and from similar experiments subsequently with the Bhatgarh concrete the result was an average of 375 lbs. on the sq. in. The proposal, therefore, was approved with the limiting condition that concrete was to be used where the pressure did not exceed 60 lbs. on the sq. in., and this method of construction has therefore been adopted.

The base of the dam, and where the pressure exceeds 60 lbs. on the sq. in., is built of uncoursed rubble masonry, between faces of hammer dressed block in course masonry of thickness varying from 3 ft. to 15 in., as shown in the section. In laying the foundations the rock at the down-stream toe was dressed throughout with a slope downward toward the center of the dam, and similarly at the up-stream toe it was dressed so as to be generally at right angles to the up-stream batter of face, of 1 in 50. The center portion, on which either rubble masonry or concrete was laid, was blasted out so as to present a rough base everywhere, as nearly as practicable at right angles to the resultant pressure. The space between the side of the excavation for founds and masonry face on the down-stream side was all carefully filled with concrete up to the surface level of hard rock. In order to pass off the river discharge, during the construction of the lower portion of the work, a working sluice was built through the dam with its sill at river bed level. This sluice or culvert is 4 ft. wide with a semicircular arch and total height of 7 ft. When no longer required it was built up for a distance of 16 ft. from the up-stream face. This portion of the sluice was built 1 ft. wider than the remainder, and with stones projecting 6 in. so as to secure proper bond. A 4-in. pipe with sluice at down-stream end was also laid in this 16 ft. of wall to pass off leakage from the mouth of the sluice which was temporarily blocked up during construction. The portion of culvert on the down-stream side remains open, and will be used to give access to the bottom of a small shaft 8 in. square, that has been built from the roof of the culvert vertically to the top of the dam. It is proposed to test the deflection of the dam by means of a plumb bob in this shaft, observations being taken when the reservoir is empty and afterward with the full water-pressure. The discharge, however, through the under-sluices during three seasons has resulted in the formation of a heavy bank of gravel and bowlders about 50 ft. from the dam, and a pool of water which completely covers up the working sluice; it will therefore probably be advisable to construct a small well up to river-bed level, with the double object of providing a water cushion or basin to protect the founds, and from which loose bowlders can be excluded, and also from which the water can be pumped to give access to the culvert, to carry out the observations for deflection.

The work was begun in July, 1881. By the end of June, 1891, the whole of the main dam was completed with the exception of the top layer of the parapets, the hand railing and road. The south waste weir was built up to within 9 in. and the north weir up to the finished crest level. The cubic contents of the dam and waste weir, when complete, will be 4,657,032 cub. ft., of which 1,512,802 cub. ft. are rubble masonry; 638,256 cub. ft. face-work and 2,505,974 cub. ft. concrete. The total cost is about $304,000.

There has been much controversy about the arrangement of the under-sluices, and some high authorities have condemned their use, while others have approved them. In their favor it was urged that they would prevent the deposit of silt by the scouring produced when they were open.

The clear opening of these sluices is 8 ft. high and 4 ft. wide; each gate of cast iron with its steel lifting rod 4½ in. in diameter weighs about 4½ tons. The top length of the lifting rod is square in section for a length of 12 ft. 6 in., machined on all sides, to work in a square guide also planed true. The top 11 ft. 4 in. of the rod is screwed, and on it fits a gun-metal nut and collar which fits in a cast-iron thrust box, bolted to the masonry at the top of the dam. A cast-iron capstan head fits the nut, and is worked by six wrought-iron arms, the end portions of which are bent so as to be horizontal at a suitable height above ground level. Additional leverage can be obtained by means of wrought-iron piping slipped over the ends of the bars. The screen in front of each gate consists of wrought-iron double-headed rails 2½ ft. from the face of the sluice weighing 66 lbs. to the yard, fixed in horizontal rows 1 ft. apart, the ends resting in grooves in the block in course masonry piers, and kept in position by vertical bars 1¼ in. in diameter. The calculated maximum velocity through the sluices is 60 ft. a second, and it is estimated that the greatest probable pressure on each rail will be less than one-third of the safe load, and one-fifteenth of the breaking load; the margin of safety is therefore very large. The only defect to be noted in the design is the position of the cage of rails with respect to the sluice. It should have been at least 12 ft. in front instead of only 2½ ft. This could have been done at some extra expense by prolonging the piers up-stream, and the cage at this distance would have minimized the danger of brushwood interfering with the working of the gate. The gates with the lifting rods, excepting the top screw length, were constructed by Messrs. Richardson & Cruddas, of Bombay, each gate being carefully tested. The two sluices for drawing off water for irrigation are each 3 ft. square and similar in design to the under-sluices. A great mistake was, however, made in these two gates by providing brass facing on the gate only, the frames on which they work being only planed cast iron. The result in two seasons is that the faces of the frames are pitted by rust, and there is no doubt that eventually brass-faced frames will have to be substituted.

The weir is divided into two portions, one in the north, the other at the south end of the dam, and in order to accommodate the road over the dam, both weirs are crossed by means of piers and arches, the clear width between piers being 10 ft. The number of openings on the north is 45 and on the south is 36, the maximum depth of discharge allowed above crest being 8 ft. The calculated discharge is 56,457 cub. ft. per second, which is in excess of the greatest known flood. The weir openings can be closed by sluice gates when required.

THE UNITED STATES NAVY.

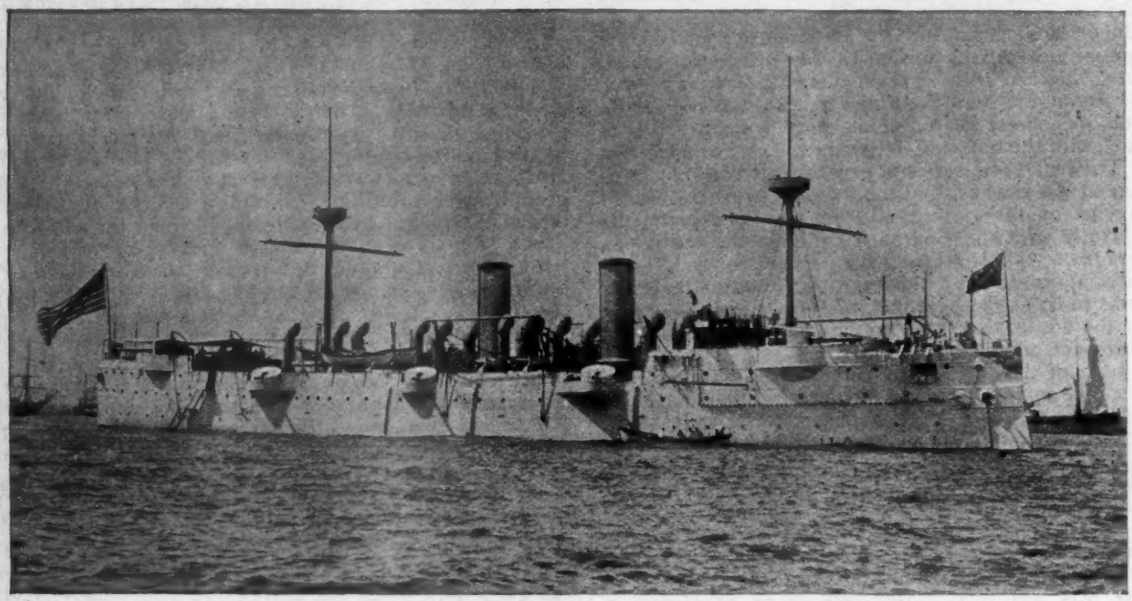
THE difference of opinion between the Senate and the House on the Naval Appropriation Bill has resulted in the adoption by a Conference Committee of a compromise report. It will be remembered that the House bill, as originally reported and adopted, provided for only one new ship, an armored cruiser of the same class as the *New York*. To this the Senate added a battle-ship, several gunboats, and a number of torpedo-boats. By the conference report the gun-boats and the torpedo-boats are

dropped and the Appropriation Bill will authorize the beginning of work on the new cruiser and one battle-ship. The plans for the latter have not been adopted, but it is understood that the new vessel will be somewhat similar to the *Indiana*, *Massachusetts*, and *Oregon*, which are already under construction.

The next new ship to be launched will be Cruiser No. 12, the fast triple-screw ship, which has been under construction for some time at the Cramp yards in Philadelphia. The date set for the launch is August 8. This vessel has not yet received a name.

It is understood that the Ammen harbor-defense ram which is under construction at Bath, Me., will also probably be launched in August. The *Cincinnati* at the New York Navy Yard is making fair progress, and may be ready for launch during the month.

At the machine shops of the New York Navy Yard, the engines and boilers for the *Cincinnati* and the *Raleigh* are about completed, and the *Raleigh's* machinery is being shipped to Norfolk. The armored cruiser *Maine* has been for some time in the dry-dock, but is making very slow progress, the delay being no fault of the authorities at the yard, however, as it is caused chiefly by the slow delivery of the armor plates. The same cause is keeping back considerably work on the double-turret monitor *Terror*.



CRUISER "BALTIMORE," UNITED STATES NAVY.

LAUNCH OF THE "TEXAS."

The battle-ship *Texas* was successfully launched at the Norfolk Navy Yard, June 28. Full descriptions of this ship have been heretofore published, and a sketch showing her general plan was given in the July number of the JOURNAL. It may be repeated here that the *Texas* is an armored battle-ship of 6,340 tons normal displacement. She is 290 ft. long; 64 ft. beam; 39 ft. 8 in. molded depth, and will have a mean draft of 22 ft. 6 in. She will have a water-line belt of armor 116 ft. long, a heavy protective deck, and an armored casemate on the main deck, which will support two turrets, in which the larger guns will be carried. The main battery will include two 12-in. and six 6-in. breech-loading guns, and the secondary battery will have a number of rapid-fire and machine guns. The *Texas* will have twin screws and triple-expansion engines. The engines and boilers have been built by the Richmond Locomotive Works.

THE CRUISER "BALTIMORE."

THE engraving given herewith is from a photograph of the cruiser *Baltimore*, one of the same general class of which the *Newark*, the *Charleston* and the *Philadelphia* are types, although the ship in question differs somewhat from the others in detail. She is a twin-screw, steel-protected cruiser, 335 ft. long over all, 48 ft. 6 in. beam, 19 ft. 6 in. mean draft, and 4,400 tons displacement. She was built by the William Cramp & Sons Ship & Engine Building Company, in Philadelphia.

The ship has a complete double bottom, and is divided into numerous water-tight compartments. There is a complete protective deck varying from 2½ in. to 4 in. in thickness. The engine and boiler space is completely surrounded and protected by the coal bunkers. All the guns are protected by heavy steel shields.

The ship is provided with an electric light plant, hoisting engines, ventilators and all the modern conveniences.

Each screw is driven by an independent horizontal triple-expansion engine. These engines have developed 10,750 H.P., and have given a speed of 20.2 knots. There are eight double-ended cylindrical boilers arranged in groups of four. The full coal capacity is 900 tons, giving a radius of movement of 3,400 knots at full speed, and of 12,000 knots at a 10-knot speed.

The armament consists of four 8-in. breech-loading rifles mounted on either side of the poop and forecastle; six 6-in. breech-loading rifles in sponsons on the spar-deck; six 6-pdr. rapid-fire guns, six Hotchkiss revolving cannon and four Gatling guns. There are also five torpedo-tubes.

The *Baltimore* has done considerable cruising since she went into commission. She was the ship chosen to carry Captain Ericsson's body to Sweden. For some time past she has been on the Pacific Coast, and at latest dates was reported in Puget Sound.

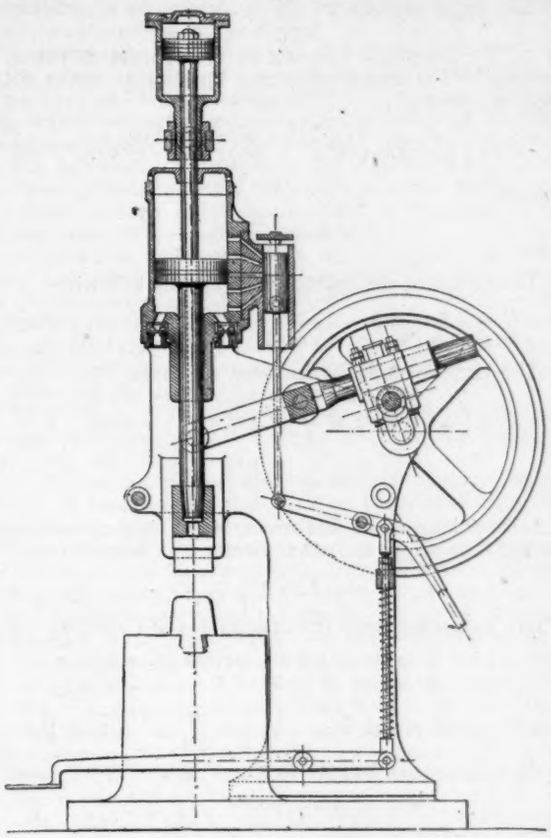
The *Baltimore* has a heavy ram bow, and a projecting stern which covers and protects the steering apparatus. She is a very handsome ship, although it must be confessed that her general appearance is somewhat marred by the large ventilators projecting above the deck. She is a good cruiser, and is said to be a very comfortable sea boat.

AN ENGLISH POWER HAMMER.

(From the London *Engineer*.)

THE accompanying illustration represents one of several varieties of the Longworth power hammer, now being manufactured by Samuelson & Company, Banbury. It will be seen that these hammers possess several novel and important features, which render them applicable to many

classes of work which could not hitherto be done by power hammers, as, for instance, the arrangement of the patent controlling cylinder and valve, whereby by means of one foot or hand lever single blows, light or heavy, can be instantaneously given, or a repetition of light or heavy blows immediately delivered, or the hammer made to stop up at once quite clear of the work on the anvil. Referring to the drawings of the forging hammer, we find that the hammer is actuated by a driving belt pulley and crank-shaft, the crank-shaft giving motion to a rocking lever, which, by means of long links and a crosshead, recipro-



THE LONGWORTH POWER HAMMER.

cates the top or actuating cylinder in a vertical direction, with little or no lateral strain, the cylinder being guided solely by its own piston and hammer-rod. The top cylinder acts upon the piston by means of the air cushions formed by the air enclosed at each end of the cylinder, so that reciprocating motion is communicated to the hammer without any knock or jar being transferred to the driving mechanism. The position occupied by the top cylinder enables it to be made large in diameter, and capable of being raised or lowered by the nuts on the crosshead; it is also free to turn round upon the hammer-rod.

The above mechanism is all that is required to give a repetition of blows with uniform force, but to vary and also to have perfect control of the blow, a fixed controlling cylinder attached to the framing of the machine is necessary. The controlling cylinder is furnished with self-acting inlet valves at bottom and outlet holes or ports at the side, the latter being closed or opened by a piston slide-valve, which is placed under the control of the foot or hand of the workman. The upper part of the cylinder is, by means of suitable openings, practically open to the atmosphere.

A piston attached to the hammer-rod works in this cylinder, and, as the hammer rises, air is drawn through the inlet-valves into the lower part of the cylinder. If now the hammer descends, and all the outlet holes are closed by the slide-valve, the air is compressed by the piston and forms a powerful cushion, sufficient not only to absorb the momentum of the blow, but to keep the hammer faces at a considerable distance apart; and as the power absorbed by the cushion of air in the down-stroke is given back to the hammer in the up-stroke, little power is required to keep the hammer working in this way, and in proportion as this opposing cushion of air is decreased, the force of the blow and the power to drive the hammer is increased, so that less power is required to drive the hammer when giving a light blow than when giving a heavy one.

As the slide-valve is lowered, thus opening the outlet holes one after the other, various degrees of cushioning are obtained, and therefore various forces of blows given, from a blow light enough to delicately touch the work, to the heaviest blow the hammer is capable of giving. By quickly lowering and raising the slide-valve a single blow can be delivered of any required force, the hammer faces keeping apart as before after each blow; and on holding the slide-valve in any desired position uniform blows can be given, or a force corresponding always with that position. The great efficiency and uniformity of the result obtained by the above system is owing to the fact that the commencing point of cushioning, or cut-off of the exit of the air, is made to take place at definite points in the length of the downward stroke of the hammer.

As the hammers described are made in sizes as light as 10 lbs. for planishing and as heavy as 10 cwt. for forging, and can be run at speeds from 500 to 50 blows per minute, they are well suited for a great variety of work.

CROSSINGS OF GREAT RIVERS.

A CONTRIBUTION TO RAILROAD LOCATION.

By A. Zdziarski, C.E.

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One of the most important problems of railroad location is the selection of suitable crossings of great rivers and an exact determination of the necessary clear openings to be made in designing these bridges. A careful study of this problem may be of great economical advantage, the cost of bridges being very high, and increasing with their length. Indeed, when a mile of railroad can be constructed for $25 000 to $50,000, a permanent bridge of one mile length will cost $2,500,000 to $5,000,000, or 100 times more.

In English and American technical literature it is difficult to find any full answer to the above questions; the same can be said of the literature of the European Continent, where great rivers do not occur—the Rhine and the Danube perhaps excepted. On the contrary, the great rivers of Russia and Siberia required that the problem of accurately determining the spans of bridges across them be studied carefully. The result of these studies I present in the following article, which contains the rules and practice adopted in Russia for the location of great bridges and the determining of their clear spans.

I.—INTRODUCTORY.

The data required for the suitable design of a bridge across a great river are the following:

1. The maximum discharge of water in the river corresponding to its higher flood.

2. The topographic plan of a part of the river near the proposed crossing, showing the limits of inundation (floods) and the direction of the high water currents.

3. The cross-section of the bed and banks at the point chosen for the crossing, with the geological structure of the soil.

4. Exact information about the variations of water level in the river, about the spring and autumn ice flows, and the thickness of ice.

5. Information concerning the navigation, and especially concerning the dimensions of vessels to be passed under the bridge.

II.—PRELIMINARY RECONNAISSANCE AND CHOICE OF A SUITABLE PORTION OF THE RIVER.

Before the beginning of the detailed examination of the river crossing, it is necessary to make a reconnaissance of it, particularly in order to chose: (1) The site for the bridge, and (2) the portion of the river suitable for the measuring and determining the discharge.

The site for the bridge should be so selected that the railroad line (the axis of the bridge) may be as nearly as possible perpendicular or normal to the direction of the current, and that the direction of the high-water current be not very different from the low-water current.

The portion of the river chosen for the purpose of measuring the discharge of water can be either at the site of the bridge or somewhat above or below it; but this portion must satisfy the following requirements: It should be nearly straight, and have a length at least equal to double the width of the river; it should have at its ends neither banks, shallows, nor sharp curves; the cross-sections should have regular outlines and an ordinary width, and moderate and uniform depths; the banks should be, if possible, not inundated.

III.—THE WATER GAUGE.

After a suitable portion of the river is chosen, there should be established there one or two water gauges (if two, one on each bank of the river) in a spot convenient for observations, and secured from running ice. The zero point of the gauge should be connected with the general level of the railroad line.

The water-gauge indications should be registered three times every day—say at 8 A.M., 1 M. and 9 P.M. Besides these sudden rises or falls of water, occasional floods and the levels of spring and autumn ice runs or floods should be exactly registrated.

IV.—DETERMINING THE MAXIMUM DISCHARGE OF WATER IN THE RIVER.

We do not need to repeat that the knowledge of the maximum discharge of water in the river is necessary for calculation of the minimum clear span of the bridge to be thrown across that river.

It is obvious that this maximum discharge corresponds to the highest level of the water; but as it is usually not probable that this highest level could be met at the time of the observations, therefore this maximum discharge can be only deduced by means of calculations based on data which may be furnished by immediate observations. For these calculations we propose two methods.

1. *The first method* (till now generally used) can be stated as follows:

The discharge corresponding to the highest observed level is immediately determined by means of measurements of the cross-sections and velocities; then from this discharge Q and the area of the cross section w is calculated the mean velocity $u = \frac{Q}{w}$. Besides this, the local slope i of the river is determined by taking the water-level for at least two miles along the shores. Then adopting one of the empiric formulas, giving the value of the mean velocity in terms of the slope i, the mean depth R (which is equal to the area of cross section divided by the width b of the river—viz., $\frac{w}{b}$), compare the measured value of the mean velocity u with the values calculated from one of the formulas $u = \int (R\ i)$, and select the formula which, for this case, gives the most available results; if necessary, change in that formula the numeric coefficients so that the calculated value of velocity coincides with the measured value immediately determined from observations.

From the empiric formulas giving the mean velocity in terms of slope and mean depth of water, we can recommend the following (all quantities given in meters):

The formula of Humphreys & Abbot, the formula of Grebenau, the formula of Darcy-Bazin, and the formula of Ganguillet & Kutter.

In all the formulas we will adopt the following notations:

u = mean velocity of current.
w = area of cross section.
p = length of wetted perimeter.
b = width of river.
R = hydraulic mean depth $\frac{w}{b}$.
r = mean radius $= \frac{w}{p+b}$, approximately $= \frac{w}{2b} = \frac{R}{2}$.
i = slope of river $= \frac{\text{fall}}{\text{length}}$.

1. The American formula of Humphreys & Abbot, deduced from experiments on the Mississippi, is the following, in meters:

$$u = \left(\sqrt{0.0035\ m + \sqrt{68.72\ r\ \sqrt{i}}} - 0.05\ \sqrt{m}\right)^2$$

where

$$m = \frac{0.933}{\sqrt{R} + 0.457}.$$

The values of the coefficient m are the following:

R =	4.5 — 3.5	2.2	1.4	0.2 meters
m =	0.18	0.58	1.07	1.10.

The same formula, in feet, has the form

$$u = \left(\sqrt{0.0081\ m + \sqrt{225\ r\ \sqrt{i}}} - 0.09\ \sqrt{m}\right)^2$$

$$m = \frac{1.69}{\sqrt{R} + 1.5}.$$

2. The formula of Grebenau, based on the experiments on the Mississippi and other rivers, is in (meters):

$$u = 8.29\ \beta\ \sqrt{r\ \sqrt{i}},$$

where β depends upon the dimensions of river—viz:

for $w = 20 - 400$ sq. meters, $\beta = 0.9223$,
$w > 400$ " " $\beta = 0.9459$.

For the great rivers, $r = \frac{w}{p+b} = \frac{w}{2b} = \frac{R}{2}$, and the formula of Grebenau has the form

$$u = 8.29 \times 0.707\ \beta\ \sqrt{R\ \sqrt{i}},$$
$$= 5.861.\ \beta.\ \sqrt{R\ \sqrt{i}}.$$

We can observe that the formulas of Humphreys & Abbot and of Grebenau can be successfully applied only to great rivers with a slope less than 0.0001.

3. The formula of Darcy-Bazin is (in meters):

$$u = \sqrt{\frac{1}{a + \frac{\beta}{R}}}\ \sqrt{R\ i},$$

where for earth bed

$$a = 0.00028 \qquad \beta = 0.0003500,$$

and for rivers sweeping over coarse sediment

$$a = 0.0004 \qquad \beta = 0.0007.$$

We can observe that this formula cannot be applied to rivers with a very small slope.

4. The formula of Ganguillet & Kutter is

$$u = \frac{23 + \frac{1}{n} + \frac{0.00155}{i}}{1 + \left(23 + \frac{0.00155}{i}\right)\frac{n}{\sqrt{R}}}\ \sqrt{i},$$

where n depends upon the kind of bed, being for

rocky bed	$n = 0.017$	$\frac{1}{n} = 59$,
earth "	0.025	40,
gravel "	0.030	33.

For the value of mean depth $R < 6$ meters, this formula gives the values of velocity about the same as the formula of Darcy-Bazin, which is much more simple; only for the greater values of R, this formula gives results which are better and more coincident with observations than the formula of Darcy-Bazin.

As above said, the value of mean velocity calculated by means of these formulas should be compared with the value immediately determined by observation, and that formula should be chosen which gives the most nearly coincident value. These formulas, with some corrected coefficients (if necessary), should be adopted for calculation of the maximum discharge.

This maximum discharge will be defined as the product of the maximum area of cross-section, and the calculated mean velocity corresponding to the highest level of water. The maximum area of cross-section is computed from the transversal profile of the cross-section of river-bed and its banks, obtained by leveling; the corresponding mean depth is deduced from the same area of cross-section, and the slope of high water is supposed to be equal to the leveled slope of the observed depth of water.

Observation. In applying the above empiric formulas, great care must be advised, this application being based on the measurement of the local slope, which is a very variable quantity. Indeed, it is stated that (1) in the same spot the slope is greater during the rise of the water than during its fall; (2) the slope of high water can be greater or less than the slope of low water, according to the form of the valley; (3) generally the slopes in narrow portions of the river are greater than in the neighboring wider stretches, etc.

II. The *second* method of determining the maximum discharge of water in rivers consists in the immediate determination or measuring of discharges corresponding to different (2, 3 or 4) levels of water in the same cross-section of the river; from this data will be deduced a formula giving the value of discharge in terms of the height of water (or water-gauge indications) for each level of water, and consequently also for the level of the highest water.

This method was deduced from many experiments made on the Saale and the Unstrutt, in Germany, and verified by the experiments on the rivers Soukhona and North Dwina, in Russia. It was also applied for the determination of the length of clear spans of bridges over the great Siberian rivers Irtish and Obi during the location of the Western Siberian Railroad in 1891 and 1892.

After having, for a chosen cross-section, determined 2, 3 or 4 values of discharge corresponding to different levels of water, we can draw a diagram in which the discharges will be the abscissæ, and the heights of water level the ordinates of a curve, expressing the relation between the discharge and the height of water level (fig. 1).

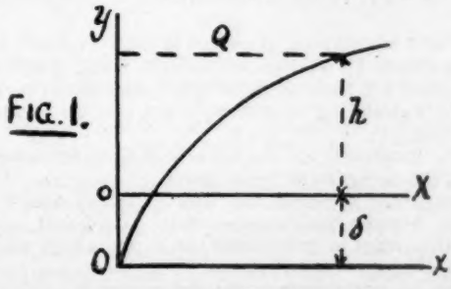


FIG. 1.

This curve may be considered as a parabola; and if we call the water-gauge indications h the corresponding discharge by Q, the ordinate of the parabola's summit by δ, and the parabola's parameter by p, then the equation of the parabola will be

$$h + \delta = \sqrt{p}\,\sqrt{Q}.$$

In order to determine the constants δ and $\sqrt{p}$, it is sufficient to have two observations of discharge; but for the sake of complete and secure results, it is better to make three or four observations in each section, and then the values of δ and $\sqrt{p}$ can be calculated according to the method of least squares; it is by formula

$$\sqrt{p} = \frac{n\,\Sigma\,(h\,\sqrt{Q}) - \Sigma\,\sqrt{Q}\,\Sigma\,h}{n\,\Sigma\,Q - (\Sigma\,\sqrt{Q})^2},$$

$$\delta = \frac{\Sigma\,h\,\Sigma\,Q - \Sigma\,\sqrt{Q}\,\Sigma\,(h\,\sqrt{Q})}{n\,\Sigma\,Q - (\Sigma\,\sqrt{Q})^2},$$

where n is the number of observations, or of different values of Q and h, and Σ the sign of sum.

Having so calculated for a given section the values of $\sqrt{p}$ and δ, we will have for the maximum value of Q, corresponding to the highest level H, the equation

$$H + \delta = \sqrt{p}\,\sqrt{Q},$$

whence this maximum discharge Q is

$$Q = \frac{(H+\delta)^2}{p}.$$

V.—THE IMMEDIATE DETERMINATION OF DISCHARGE.

As above said, in order to calculate the maximum discharge of water in a river it is necessary to determine immediately several different values of discharge corresponding to different heights of water level—say high, middle and low.

All these determinations of discharge should be made in the portion of the river previously chosen for this purpose, and besides them in the cross-section corresponding to the site of bridge. In the chosen portion of the river, the determination of discharge should be made in three sections normal to the direction of the current and situated from 300 to 600 ft. apart. The determination of discharge in the cross-section corresponding to the bridge is not so important, and if this cross-section is very irregular, divided by islands or shallows, then it can be set aside altogether.

In order to secure the perpendicularity of cross-sections to the direction of the current, the latter must be, if possible, exactly determined. For that purpose, in calm weather a small boat with one observer is driven in different places of the river, and in such manner that following the current he shall cross all the sections previously selected, which should be duly designated by means of posts driven on the shore. Another observer, with a theodolite, or transit, or a surveyor's table, follows the movement of the boat. When the boat enters the line of one of the preliminary sections, the observer in it makes a sign by means of a flag, and at the same time the observer on shore measures the angle or draws the direction on the table, and the position of the boat is determined. The consecutive positions of the boat give the line and direction of the current, perpendicular to which the definitive sections should be drawn.

If the character of the river is such that the portion of it selected for the measurements of discharge is far from the line of the bridge crossing—because the bridge can of course cross the river in a spot not suitable for the accurate measurement of the discharge—then the determination of this discharge should be chiefly based on measurements performed in this regular portion of the river, and the cross-section corresponding to the bridge should be only exactly calculated by sounding the channel and leveling the shores.

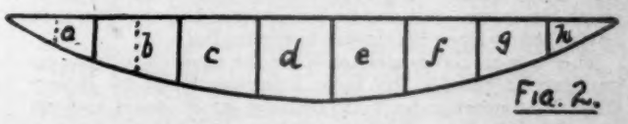


FIG. 2.

The determination of discharge in the cross-sections chosen for that purpose should be made in the following manner: Divide the cross-section of the river bed by means of equidistant verticals into a given number of trapezes—a, b, c . . . k (fig. 2)—determine for each vertical the average velocity of water v, and supposing that this average velocity in the vertical is equal to the mean velocity of the water flowing between the verticals drawn at the centers of the neighboring trapezes, calculate the discharge Q as the sum of the partial areas of the cross-sec-

tion multiplied by the corresponding mean velocities—viz.:

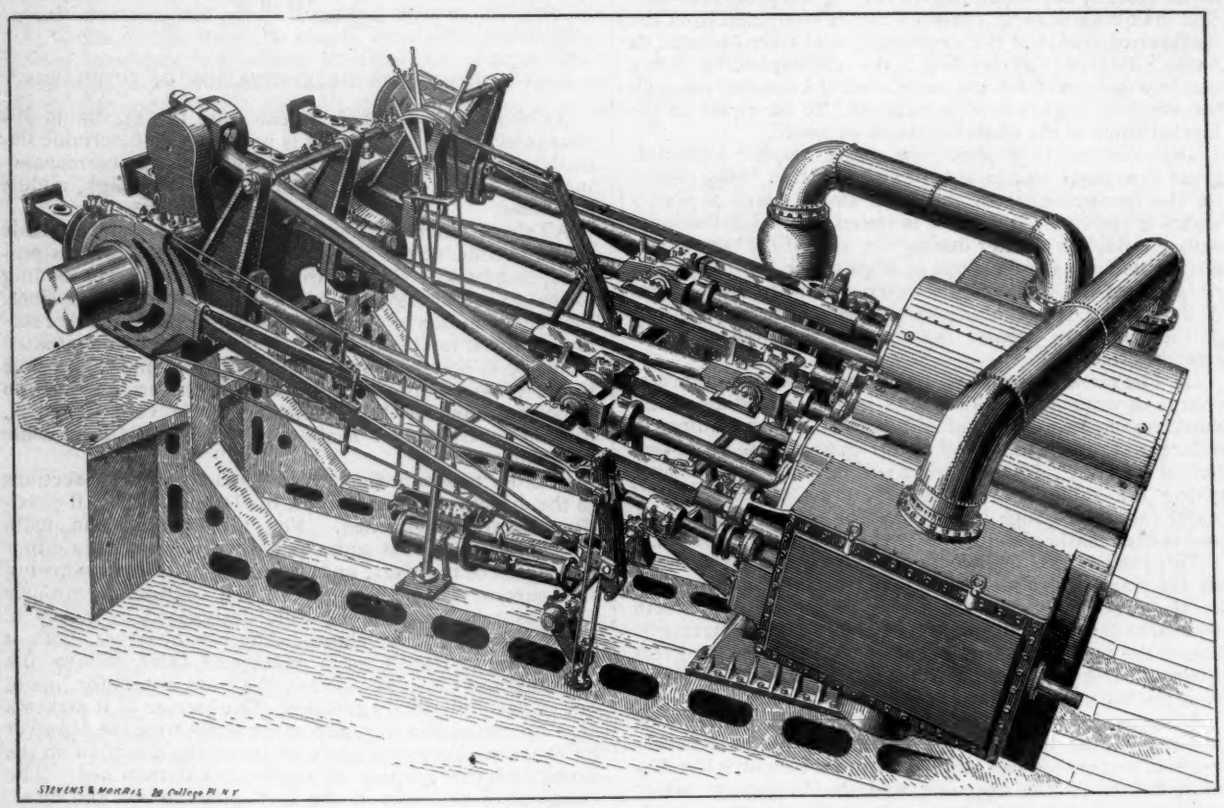
$$Q = \left(a + \frac{b}{2}\right) v_{ab} + \frac{b+c}{2} v_{bc} + \ldots + \left(\frac{g}{2} + h\right) v_{gh}.$$

(TO BE CONTINUED.)

A NEW TYPE OF SIDE-WHEEL ENGINES.

THE illustration given herewith is from a photograph of the engine recently built by the Cleveland Ship Building Company, Cleveland, O., for the side-wheel passenger steamboat *City of Toledo*. This engine is believed to be the first inclined triple-expansion three-crank engine built of steel castings. The air-pump is operated independent of the main engine, and is of the duplex type, having 14-in. steam-cylinders, 20-in. air-cylinders, and 20 in. stroke. The wheels are of the feathering type, 19½ ft. outside of the floats, which are of steel 9½ ft. wide, there being nine to each wheel. The manner devised by the engine-builders for supporting the engine in the hull is noteworthy from the fact that there is a total absence of vibration, even when running at highest speed. This is indicated in the engraving, and has been accomplished by a judicious combination of partial horizontal and vertical bulkheads.

Two boilers 10 ft. 10 in. diameter by 21 ft. long, of the gun-boat type, furnish steam at 160 lbs. pressure. Each boiler has three 46-in. furnaces, and they are run with natural draft. On trial these engines have developed 1,641 indicated H. P., running at 40 revolutions per minute.



TRIPLE-EXPANSION ENGINE FOR SIDE-WHEEL STEAMER "CITY OF TOLEDO."
BUILT BY THE CLEVELAND SHIP BUILDING COMPANY, CLEVELAND, OHIO.

in this country; the builders certainly deserve credit for making a very compact and serviceable engine, which is well adapted for a high-speed side-wheel boat, takes up much less room, and can be better placed in the ship than any of the engines heretofore in general use.

The *City of Toledo* was built for the passenger business between Toledo and the Lake Erie islands, which is very large in summer; she is 210 ft. long, 32 ft. beam and 12½ ft. molded depth. Her hull is of steel and the passenger accommodations are excellent. The boilers and machinery being all below the main deck, and the wheels not rising above the promenade deck, there is an unusual space available, and full advantage has been taken of it in fitting her up.

The engine, which is shown in position, has cylinders 26, 42 and 66 in. diameter by 72 in. stroke. The high-pressure cylinder is placed between the intermediate and low-pressure cylinders, and has a piston-valve actuated by a Joy radial valve-gear; the intermediate and low-pressure cylinders have double-ported slide-valves and ordinary link-motion. The steam-pistons are made very deep and have a special arrangement for taking up wear; the piston-rods are of steel; connecting-rods, guides, shafts and crank-pins of scrap-iron forgings; and cranks

A feature of this type of engine is the very small amount of space taken up on the main deck, being merely room for the cranks to turn, and for operating platform back of cranks. Ventilating trunks only are run up through the upper deck.

Mr. A. Angstrom, of the Cleveland Ship Building Company, is the designer of the engines.

The contract speed of the *City of Toledo* was 16 miles an hour; but she has exceeded that, having put on record a run of 16 miles in 47 minutes, or at the rate of 20.4 miles an hour.

THE LOCOMOTIVE PROBLEM AGAIN.

IN the RAILROAD AND ENGINEERING JOURNAL for April last there was given the following

PROBLEM.

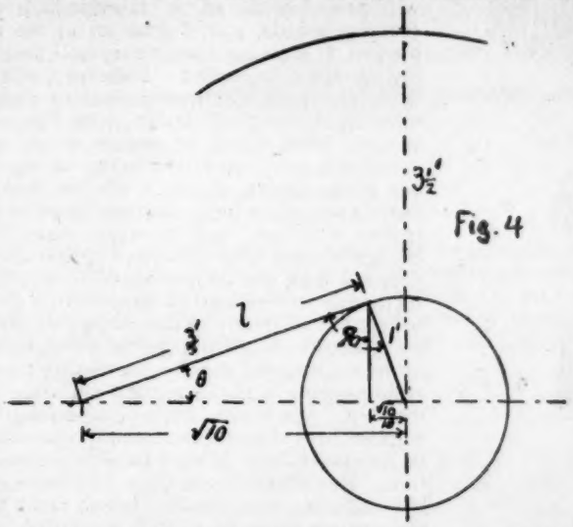
Let it be supposed that the stroke of the pistons of a locomotive is 2 ft., the diameter of the driving-wheels 7 ft. and the speed 60 miles per hour; what is the maximum and minimum velocity of the piston relatively to the earth, and not with regard to the locomotive, and when does each occur?

Four answers to this problem were received and published in the July number, without comment. The following additional answer has since been received :

V.—BY EDWARD WALKER, NEW YORK.

The answers to the Locomotive Problem published in the July number of the JOURNAL do not seem to be quite correct. Nos. I, II and III are incorrect ; and No. IV, though correct scientifically, is unnecessarily complicated, and its assumption that the connecting-rod is 8 ft. long is not in accordance with practice.

The speed of the piston and cylinder is 88 ft. per second ; to or from this must be added or subtracted the



maximum speed of the piston relatively to the cylinder. The greatest speed of the piston is when the connecting-rod is at right angles with the radius at the crank-pin, and its speed is then $= cos.\ \theta \times$ speed of crank-pin. The speed of the crank-pin is $88 \times \frac{2}{7}$, and the speed of the piston is $\frac{88 \times 2}{7} cos.\ \theta$. The value of θ depends on the length of the connecting-rod. I suppose 3 ft. would be a good average for 2 ft. stroke. The maximum and minimum speed of the piston relatively to the earth would then be 111.85 ft. per second and 64.15 ft. per second respectively.

The position in the stroke where this maximum and minimum speed occurs is at

$$1' \times sin.\ \theta = \frac{1}{\sqrt{10}}, \text{ or, } \frac{\sqrt{10}}{10} = 0.316$$

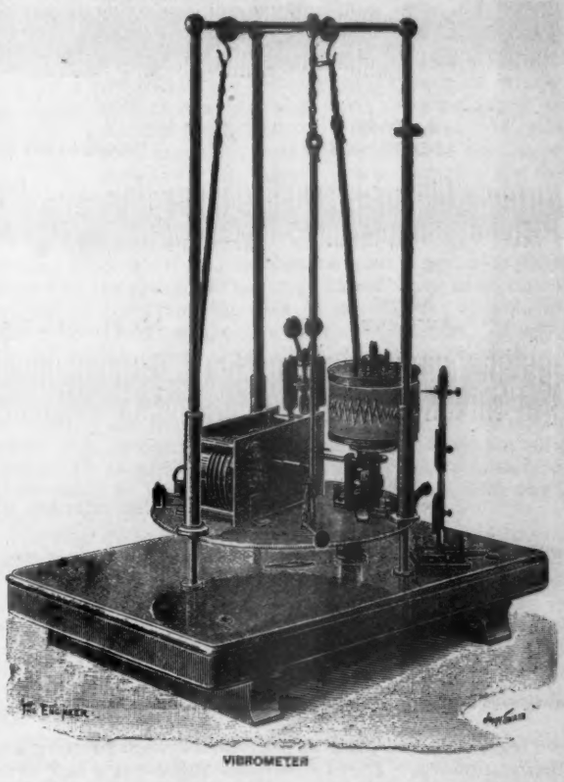
to the left hand of the stroke in fig. 4.

BALANCING MARINE ENGINES AND THE VIBRATION OF VESSELS.

(Paper read by Mr. A. F. Yarrow before the Institution of Naval Architects ; from the London *Engineer*.)

ALL who are acquainted with the working of steamers provided with large power and of high speed, such as torpedo-boats, torpedo-boat catchers, and very fast passenger steamers, will be familiar with the fact that they are subject to considerable vibration under some conditions, especially since the adoption of steel for ship-building and high piston speed. To overcome it is daily becoming a matter of increasing importance, as higher and higher speeds are being continually demanded. It is to a study of the laws which govern this vibration, and to the possibility of avoiding it, that I invite your attention.

I will first describe some experiments which we have carried out during the last few years, with a view to throw light upon the subject. At the outset we felt the want of some means of accurately indicating and recording the extent and character of vibrations, and therefore devised an instrument for the purpose, which has been named a "vibrometer." This instrument is shown in the first engraving given. It has been in use for the last six years, and is, I believe, trustworthy. It consists, as will be seen, of a heavily weighted drum, suspended by elastic connections. This drum is provided with suitable clockwork to cause it to revolve, and is regulated to make one revolution per minute. Attached to an upright fixed to the stand of the machine is a pencil, which presses lightly against the drum, round which a sheet of paper is wrapped, in the same manner as in an ordinary indicator. It will be readily understood that if the base of this instrument be placed upon a platform or the deck of a vessel subject to vertical vibration, this movement will be transmitted to

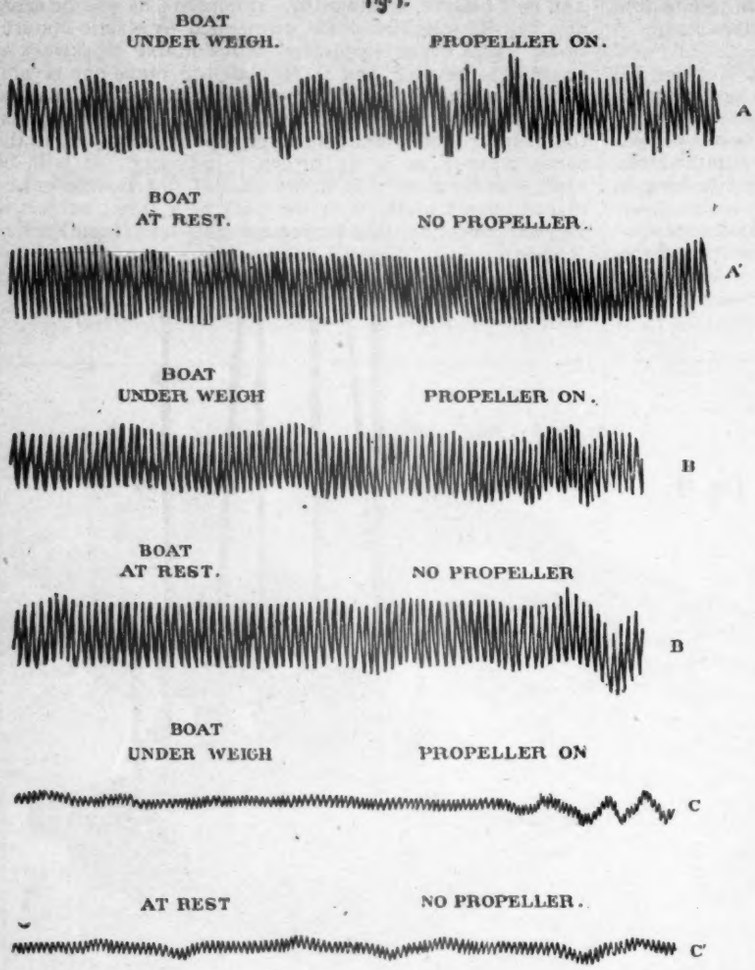

VIBROMETER

the whole apparatus, excepting that portion which is suspended by the elastic connection, and this, being heavily weighted, will not follow the vibratory motion of the stand. Now, if we place our instrument on the stern or any part of a steamer which is vibrating, and start the drum revolving, the pencil, being pressed against the paper, makes a line, indicating the relative vertical positions of the pencil and the paper, or, in other words, makes a diagram which records the character and extent of the movement of that part of the ship upon which the instrument stands.

I believe the cause of vibration in screw vessels, when running in smooth water with their propellers well immersed, to be mainly due to the forces produced by the unbalanced moving parts of the machinery, such as the pistons, piston-rods, valves, gear, etc., excepting when it is the result of bad workmanship or bad state of repair. For example, as clearly pointed out by Mr. Barnaby in his treatise on "Marine Propellers," vibration may be set up by a screw, the center of gravity of which is out of the center line of the shaft, or it may be due to want of uniformity in the position, area or shape of the blades. These causes being avoidable by proper care, I do not propose to deal with them. I would, however, take this opportunity to observe that sufficient attention is not always paid to these points.

From our experiments we have overwhelming proof that the vibration in a torpedo-boat is precisely the same in extent and character when the screw is on, and the vessel driven by it through the water, as it is when the boat is stationary and the engines simply revolving without doing work, the propeller being removed. To prove that this statement is correct, attention is called to fig. 1, upon which are shown enlarged vibrometer diagrams, which

Fig. 1.



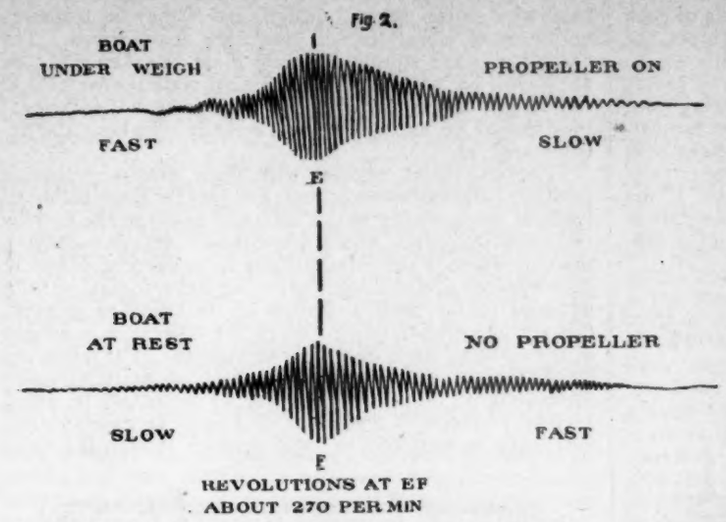
have been obtained from torpedo-boats when running and when stationary. These diagrams represent a fair average of over a hundred results. It will be seen that diagrams A and A^1 are practically alike; also diagrams B and B^1, and diagrams C and C^1, A, B and C having been obtained when the boat was under weigh with propeller on, and A^1, B^1 and C^1, when the vessel was stationary, being without propeller. The engines were making exactly the same number of revolutions in each corresponding pair of diagrams. Not only do these diagrams prove that the screw had nothing to do with the vibration, and that it was owing to the working of the machinery, but it will be seen how greatly our investigation is facilitated by these facts, because experiments can be carried out with a boat at rest, and we know that the same results as regards vibration will be found under ordinary working conditions.

It is a well-known fact that engines will impart their vibration to a boat at certain speeds much more readily than at other speeds, and it often happens that at full speed a boat may be practically steady while at a slower speed the vibration is excessive. This is dependent upon the extent to which the movements of the reciprocating parts of the engine correspond with the period of vibration of the hull, which may be considered in this investigation as an elastic body. This is illustrated by the well-known fact that when soldiers are crossing a suspension bridge, it is often found necessary to avoid their marching in step. Some years since we had a boat in which severe vibration occurred at 200, 400, 600 and 800 revolutions per minute, but there was none at the intermediate speeds of 300, 500 and 700. The diagrams in fig. 2 show very clearly how the vibration varies at different speeds, and the variation that takes place in the extent of the vibration when passing from one speed to another.

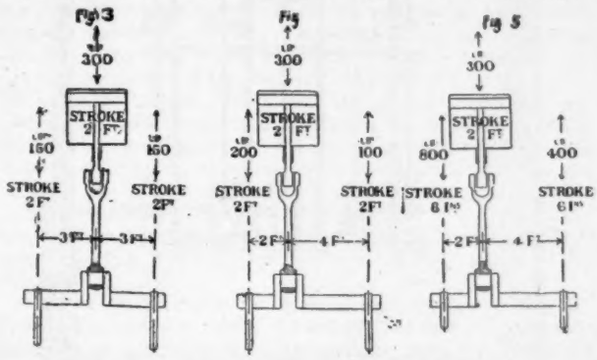
In a vessel such as a fast Atlantic liner, which is intended to run continuously at a nearly uniform speed—unless special means be taken to balance the machinery—it is of the utmost importance to carefully avoid the number of revolutions of the engines per minute keeping time with, or, in other words, synchronizing with the normal vibration of the hull. This cannot be carried out in the case of war ships and others which are intended to run at varying speeds; for if the speed of the engines be proportioned so as not to set up vibration at full speed, they will probably do so at intermediate or cruising speeds, and if they set up no vibration at cruising speeds they will probably vibrate at full speed. I believe it would be by no means a difficult matter to determine in the original design, with fair accuracy, what speed of engine would be suitable to avoid vibration being set up in any given design of hull. We frequently hear of propellers being changed in order to reduce vibration, and in many cases the change is made with advantage; but it often happens that the improvement is not directly due to the altered shape of the propeller, but indirectly to the change causing an alteration in the number of revolutions of the engine, and thereby preventing them synchronizing with the natural vibration of the ship. We hear of hulls being strengthened or built stronger than would otherwise be necessary, with a view to reduce vibration. Doubtless this is done with more or less success; due possibly not so much to the greater strength of hull, but rather to the period of vibration being modified by this stiffening, so as to avoid its harmonizing with the movements of the machinery. Building vessels of greater strength than would otherwise be necessary, with the object of avoiding vibration, cannot be considered a scientific method of dealing with the difficulty, if it can be proved that vibration can be avoided by other means and without extra weight, because extra weight of material added to the ship tends to handicap its speed. The true cause of vibration being due to the machinery, I think it will be admitted that the correct mode of dealing with it is to so design the engines that they may be steady within themselves and free from any tendency to cause the hull to vibrate. As a further proof that the vibration is due to the machinery, I may mention that two years ago I made a passage to the United States in one of the very fast twin-screw steamers. I selected a berth in the central portion of the vessel, thinking it a good position for comfort, but the vibration was found to be so excessive that after five days it was scarcely bearable to those passengers whose berths, like my own, were situated at the points of greatest vibration. The vibration was found to vary periodically. When the two low-pressure pistons were descending at the same time it was excessive, but when one low-pressure piston was ascending and the other descending it was entirely neutralized. So distinct was the vibration in my cabin that it was quite easy to count the number of revolutions of the port and starboard engines, and we rigged up a temporary vibrometer on our cabin side, which gave us diagrams, indicating clearly the movements we were subject to. I believe all who have studied the subject of vibration in steamers will agree with me that many vessels which vibrate considerably are in consequence credited with weakness, while in reality they are of ample strength, the fault resting entirely with the engines and not with the hull. Not only is this vibration a source of discomfort to passengers, but it clearly adds considerably to the wear and tear of the vessel.

Let us consider exactly why an engine produces vibration. In an ordinary inverted engine the steam presses on the cylinder cover and on the piston, and from the piston the stress is transmitted to the bed-plate. Now, during

Fig 2.



the first half of the down stroke the upward pressure on the cylinder cover is greater than the downward pressure on the bed-plate to the extent of what is needed to set the reciprocating parts in motion, and this excess of upward over downward pressure lifts the engine bed and that portion of the hull to which it is attached. By a like train of reasoning it can be shown that during the latter half of the down stroke and the first half of the up stroke the tendency is to lower the engine bed; also that during the second half of the up stroke the tendency is to raise the engine bed. To sum this up in a few words, during the upper half of the revolution the engine tends to lift the vessel, and during the lower half to depress it. The main principle which governs the whole matter may be thus summed up: As no internal force can move the center of gravity of a body, it follows that any momentum generated by steam pressure in the moving parts, such as the piston, etc., must be attended by an exactly equal momentum in the rest of the ship in the opposite direction.

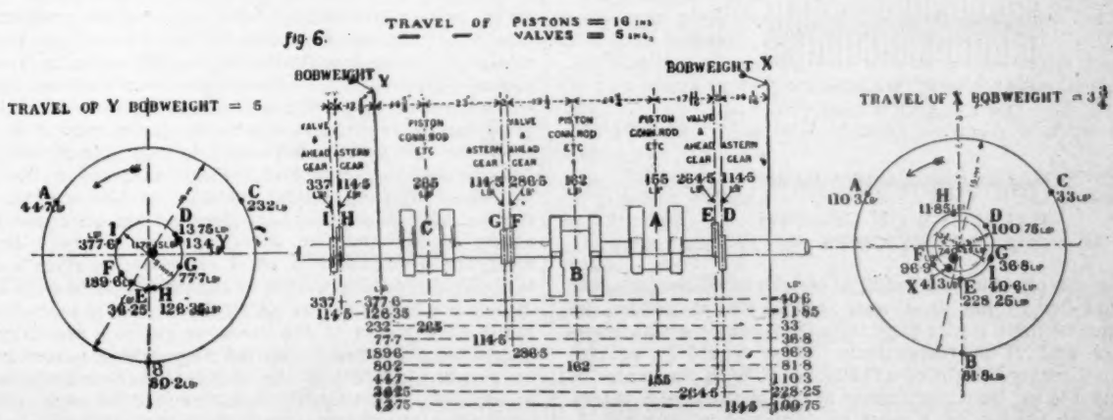


We will now pass on to consider how to design engines so that they may be perfectly free from vibration. For this purpose reference is made to fig. 3, representing a single-cylinder inverted engine, which for the sake of simplicity we will assume has no valve gear. The revolving parts, such as the crank, crank-pin, and a portion of the connecting-rod, can be balanced by means of rotary weights in the usual way, and we then have only the vertical unbalanced parts, such as the piston, piston-rod, etc., left to deal with. Now, if we have two eccentrics set opposite to the crank, at equal distances from it, and of equal stroke to it, and these impart an up-and-down motion to weights, which we will call "bob weights," each of which is half as heavy as the parts to be balanced, that piece of mechanism will revolve free from vibration, excepting that which is due to the angle of the connecting-rods. If we wish to place these weights at unequal distances from the crank—see fig. 4—they must be proportioned to vary in weight inversely as their distances from the crank; that is, if one weight be twice as far from the center of the crank as the other, it will have to be half the weight of the other, the sum of the weights in this case being the same irrespective of their position. If we desire to reduce the stroke of these weights so as to obtain a convenient length of stroke—see fig. 5—we shall then have to increase their weight inversely as the stroke; that is, if we quarter the stroke the weight will have to be quadrupled, and so forth. It will thus be seen to be a simple matter to proportion the bob weights, their stroke, and their position, to suit what may best work in with any design of engine.

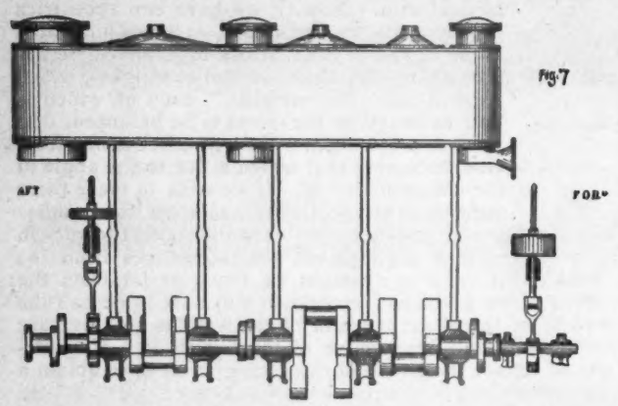
To sum up in a few words what must be done to avoid the effect of the momentum generated by the working parts being felt by the hull, an equal momentum in an opposite direction should be produced. If, instead of using bob weights, rotary weights of equal amount had been employed, having their centers of gravity in the same position as the centers of the eccentrics, which give motion to the bob weights, the engine would still be balanced vertically, but would be unbalanced horizontally.

Attention is now called to fig. 6, showing the calculation as applied to triple-expansion vertical engines. The most suitable positions are first determined for fixing the two eccentrics which give motion to the bob-weights, in this case the one lettered *X* being at the forward end of the engines and the other lettered *Y* being between the low-pressure crank and its valve eccentrics. Each unbalanced moving part in the engine is then dealt with separately, as before described, and the position and amount of the weights necessary to balance it ascertained, the stroke of the balance weights being taken, for the purposes of calculation, as equal to the stroke of the part they balance in each case. For instance, take the middle-pressure piston, piston-rod, etc., lettered *B*, the unbalanced reciprocating parts of which weigh 162 lbs., the balance required at *X* is

Fig 6.

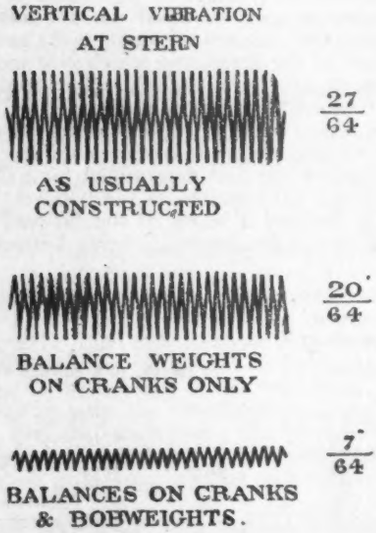


found to be 81.8 lbs., and at *Y* 80.2 lbs., the stroke of each being 16 in. Taking another instance, for example, the high-pressure valve and its go-ahead gear, lettered *E*, weighing 264.5 lbs., the balance at *X* is found to be 228.25 lbs., and at *Y* 36.25 lbs., the stroke of each being 5 in. After dealing in a similar manner with all the reciprocating parts, if we were to construct two uniform disks with each of the weights thus found pinned on in its proper relative position, and place them respectively at *X* and *Y*, the engine would be balanced vertically. All the weights at *X* might be replaced by one large weight equal to the sum



of them, and having the same position of center of gravity; in a like manner the weights of *Y* may be dealt with. These are shown by the large black spots on the diagrams. These, again, might be substituted by larger or smaller weights as convenient, situated nearer or further from the center of the shaft, the amount of the weight being in the inverse ratio to the distance from the center. It will be seen

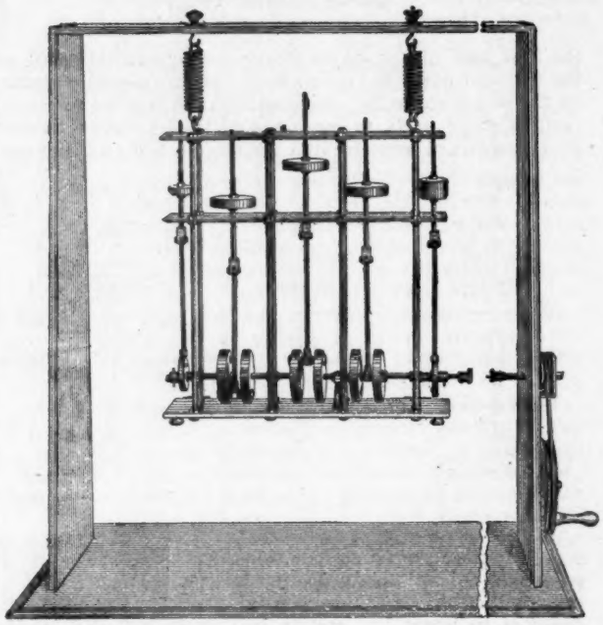
Fig. 8



that in the present case the total weight of all the balances equaled 740.25 lbs. at *X* and 1178.15 lbs. at *Y*, and the distance of their center of gravity from center of shaft was 1.04 in. and .28 in. respectively; these would be equivalent to a rotary weight of 413 lbs. at *X*, with its center of gravity 1⅞ in. from the center of the shaft, and a rotary weight of 134 lbs. at *Y*, with its center of gravity 2½ in. from the center of the shaft; these two weights would balance the engine vertically, but would set up side vibration. To avoid the latter and retain only the vertical effect, the use of bob weights equal to the rotary weights and having the same vertical motion, and in the same relative position on the shaft, are substituted. This method was adopted in the engines we shall refer to later on.

The correctness of this mode of calculation is confirmed by experience in practical working. The exact amount, position and stroke of the bob weights can be accurately calculated in the original design, and if they be made accordingly no vibrations will take place at any speed. The calculations are simple, but care must be taken that they are based on accurate data. To estimate the weights of the reciprocating parts from drawings is not sufficient; they should be ascertained by actually weighing the finished articles.

Triple-expansion engines with three cranks, although partially balanced when at rest, are very far from balanced when at work, owing to the distance between the various reciprocating parts, which consequently set up a rocking motion, which is the principal one to be overcome, and in such engines this rocking motion we have to deal with in addition to the vertical motion of the center of gravity, this vertical motion being due to the difference in weight of the working parts of the three engines. The positions of the bob weights should be chosen so as to minimize their weight. What weight may be necessary to avoid vertical vibration of the center of gravity is constant, but what may be required to avoid rocking motion is dimin-



MODEL ILLUSTRATING VIBRATION OF TRIPLE-EXPANSION ENGINES.

ished by an increased distance apart of the weights. In double-cylinder engines with the cranks at right angles it is a more pronounced galloping motion—that is, a motion of a complex kind, being a compound of vertical motions of their center of gravity and a rocking motion. In a single-cylinder engine the vibration of the engine is practically up and down; but with whatever type of motion we have to deal the same principle of balancing holds good. All forces causing vertical vibration can be neutralized by the use of bob weights, arranged to set up equal forces acting in an opposite direction. Some years ago we thought the vibration in triple-expansion engines was due to the difference in weight of the pistons, and with a view to balance them and, as we supposed, avoid vibration, we made each piston of the same weight in a first-class torpedo boat; thus we prevented any vertical movements of the center of gravity of the engines; yet we found no improvement. This clearly indicates that the rocking vibrations are of more importance than the vertical vibrations in triple-expansion engines.

There is one feature about the vibration of vessels which deserves attention, that it varies in intensity at different points in the length of the hull; there are places where it is excessive, and places termed nodes where it does not exist. Fig. 7 represents some engines indicating about 1,100 H.P. for a first-class torpedo boat, 130 ft. in length by 13 ft. 6 in. beam, having a speed of from 22 knots to 23 knots, carrying a load of 20 tons. There is nothing special about the engines excepting the two eccentrics fixed

on the shaft at each end, working vertical bob weights. To the cranks were fitted weights sufficient to balance them, the crank pins, and partially the connecting-rods. How far each connecting-rod was balanced by rotary weights was determined by its weight and the lateral movement of its center of gravity; what remained unbalanced was balanced by the bob weights worked by the eccentrics, their stroke and weight being calculated as already explained when describing fig. 6. Experiments were made with this boat in the Thames and also in the West India Dock. We tried her under three conditions—(1) without any balance weights whatever, as engines are usually constructed; (2) with balance weights on the cranks only; and (3) with balance weights on cranks and bob weights. The amount of vertical vibration at the stern as obtained in the river is given on fig. 8, together with enlarged vibrometer diagrams, from which it will be seen that the results corresponding to the three conditions show a vibration of $\frac{21}{64}$ in. as usually made, $\frac{20}{64}$ in. with balance weights on cranks, and $\frac{7}{64}$ in. with balances on cranks and bob weights. I have not the slightest doubt, from more recent experience, that this small vibration that remained could still further be reduced, and in fact practically avoided altogether, by taking greater care in accurately ascertaining the weight of all moving parts. The foregoing trials were all made at 248 revolutions per minute, which corresponded in this boat to the speed producing maximum vibration—that is to say, when the movement of the engine synchronized to the greatest extent with that of the boat. I believe that the vibration of the largest Atlantic liner can in this way be practically overcome by the expenditure of a few hundred pounds, if carried out in the original design. Bob weights proportioned and arranged as already described may be reduced in amount if wished, being substituted by a rotary balance weight equal to such reduction; this, however, must not be carried out to an extent to produce sensible side vibration.

Some instantaneous photographs taken during these trials showed in a very interesting way the degree of vibration by the peculiar ripples produced on the surface of the water.

To further illustrate the system and prove its correctness, I had made a model corresponding to a triple-expansion engine; the weights of the pistons have been similarly proportioned to one another, as in our torpedo boat engines. The shaft is made to revolve by a flexible wire, so as to avoid the result being vitiated by the mode adopted for causing it to revolve. This model engine is suspended by springs in order to be quite free to move vertically, as shown in the last engraving given.

When this model engine is put in motion unmistakable vibration is at once set up. The rotary weights, such as crank, crank-pin and lower ends of connecting-rods, are all carefully balanced by balanced disks, and consequently this vibration is due entirely to the vertical moving parts. When we connect on each side the bob weights the amount, stroke and position of which have been arrived at by a similar calculation to that already described, the effect of these bob weights in completely avoiding the vibration becomes very clearly apparent, thus serving as further proof of the facts shown by the previous experiments.

MASTER MECHANICS' ASSOCIATION REPORTS.

A NUMBER of reports were submitted to the Master Mechanics' Association at the Saratoga Convention. The longest report and the one which attracted most attention was that upon Compound Locomotives, which has been referred to separately. The report on Uniform Locomotive Performance Sheets is given in full on another page. Of the others we present a brief summary below.

BOILERS FOR HIGH-PRESSURE LOCOMOTIVES.

This Committee states that there is some difference of opinion as to what is high pressure in a locomotive boiler. Not long since 150 lbs. was considered high, but this has now become common and the Committee has therefore decided to call anything in excess of that high pressure. As a matter of fact 160 lbs. is not uncommon, and 180 lbs. is frequently used with compound engines, while 190 and 200 lbs. are advocated. A number of designs for boilers have been submitted to the Committee and transmitted by them to the Association. The Belpaire type of boiler seems to be meeting with considerable favor, and the substitution in other types of boiler of radial stays for crown-bars on the fire-box is also increasing. In all types of boiler the greatest trouble seems to be given by broken stay-bolts near the top of the fire-box, but it is believed that this can be to some extent avoided by increasing the length of the stay-bolts, reducing the width of the fire-box at the top. This would somewhat diminish the heating surface, but this would be offset by the increasing life of the stay-bolts and the freer steam. The Committee believe that the reduction of transverse strains in the stay-bolts obtained by increasing their length is much greater than is generally supposed. Good practice also requires that the water-spaces should be made as wide as possible, and that the mud-ring should be increased in size and double riveted. It is also important that there should be as few joints as possible, that the sheets should be made as large as the design of the boiler will permit, and that the waist or cylinder part of the boiler should always be in one sheet. The Committee considered that the radial-stayed and Belpaire types will meet with general acceptance, and that they are at present to be considered as the best forms of boiler for locomotive purposes.

AIR-BRAKE AND SIGNAL INSTRUCTIONS.

The Committee on this subject presented a code of air-brake and signal instructions, which was adopted jointly with the Committee of the Master Car-Builders' Association on the same subject. This code will be published in pamphlet form, and will be adopted as the standard of the Association.

TESTS OF STEEL AND IRON.

The Committee on this subject made a number of experiments intended to decide whether it is true that at a blue heat—about 600°—steel is extremely liable to crack in bending. Other experiments were also made to ascertain the relative value of steel and iron tubes, to determine the temperature of fire-box sheets and the effect of vibration upon stay-bolts.

The results of the investigations so far may be summarized as follows:

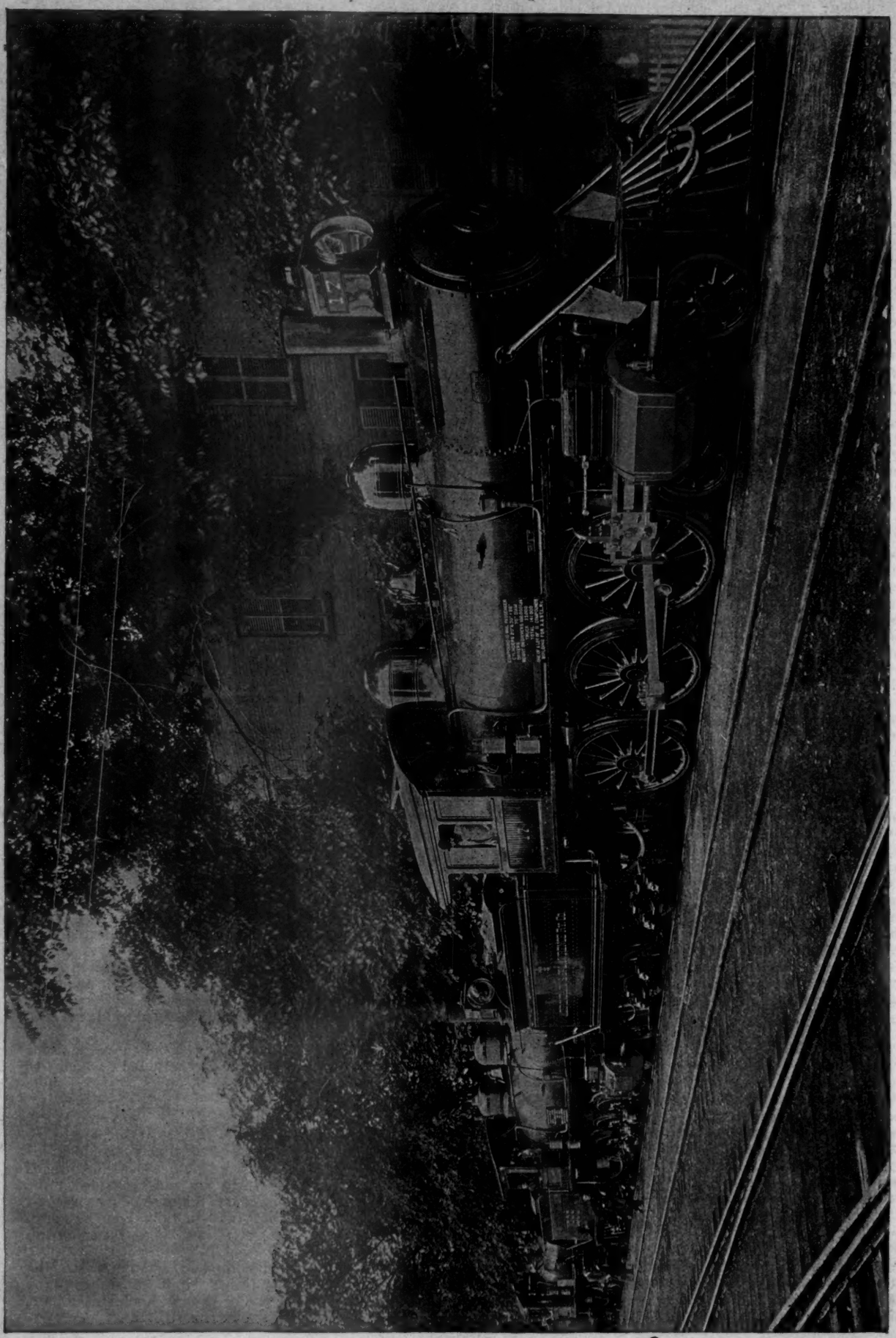
1. Steel or iron should not be worked at a temperature between a normal temperature and a perceptible red heat.
2. So-called "blue heat" makes steels and irons more brittle, but some are apparently less affected by the blue heat than others.
3. The test of steel or iron at a blue heat is not a criterion by which to judge of the action of the same in a fire-box.
4. Iron at a blue heat is more seriously affected than steel.
5. There is apparently a mechanical disintegration going on in plates exposed to the action of fire, water and scale in a fire-box.
6. Steel tubes do not seem to be as durable as iron tubes.

The Committee do not consider that their investigations are conclusive, and ask that they be continued; which was approved by the Convention.

STANDARD BOLTS AND NUTS.

This Committee gives a brief historical account of the adoption of the Sellers or United States standard for screw threads, and describes the gauges used for threads and for taps and dies, which are now considered the standards of the Association. Some excellent recommendations as to practice in fitting up bolts are also made. In conclusion the Committee makes the following recommendations:

1. That the Association commend and emphasize the United States standard, and urge a rigid adherence to the same, and deprecate the use of over or under-sized bolts and nuts.



COMPOUND LOCOMOTIVES AT THE SARATOGA CONVENTION.

2. It is practicable to maintain the standard with the methods and gauges available.

3. It recommends the adoption by the Association of the United States standard for size of nuts, based upon rough size, regardless of finished nuts.

These recommendations were approved, and the Committee was instructed to prepare a circular calling attention to their importance.

AN EXHIBIT OF COMPOUND LOCOMOTIVES.

THE engraving given herewith is from a photograph of the exhibit made by the Schenectady Locomotive Works at the Master Mechanics' Convention at Saratoga. It included three engines of the two-cylinder compound type which the Schenectady Company has advocated and adopted, and of which it has already built quite a number.

The first of these engines and the one, from its position, shown most prominently in the engraving was a ten-wheel passenger engine built for the new Adirondack & St. Lawrence Railroad. This engine is built for fast passenger service on a line with heavy grades, and is a powerful machine. The high-pressure cylinder is 20 in. and the low-pressure 30 in. in diameter, both being 26 in. stroke. The driving-wheels are 70 in. in diameter. The forward drivers have plain tires; the total wheel-base is 23 ft. 3 in., the driving-wheel-base 12 ft. 6 in. and the rigid wheel-base 6 ft. 5 in. The total weight of the engine is 141,000 lbs., of which 108,000 lbs. are carried on the drivers and 33,000 lbs. on the truck. The tender is of the usual pattern, and the tank will hold 4,000 gallons of water.

The second engine in the row is a twelve-wheeled freight engine for the Southern Pacific Company, having eight coupled drivers and a four-wheeled truck. This engine has a high-pressure cylinder 20 in. and low-pressure 29 in., and 26 in. stroke. The proportion of the cylinders is 1 : 2.10, or slightly different from the engine first described, where the proportion is 1 : 2.25. The driving-wheels are 51 in. in diameter. The total wheel-base is 23 ft. 7 in.; the driving-wheel-base, 13 ft. 9 in., and the rigid wheel-base 9 ft. 2 in. The total weight of this engine is 138,800 lbs., of which 20,000 lbs. are carried on the truck and 116,800 lbs. on the drivers. The tender will carry 4,000 gallons of water.

The third engine, which is not very clearly visible, owing to its position in the line and the angle at which the photograph was taken, is a Mogul freight engine, with six drivers and a two-wheeled truck. This engine has cylinders 20 in. and 30 in. in diameter and 26 in. stroke; the driving-wheels are 57 in. in diameter. The total wheel-base is 21 ft. 11 in.; the driving wheel-base is 14 ft. The total weight is 132,500 lbs., of which 114,500 lbs. are on the drivers and 18,000 lbs. on the truck. An engine of this type recently did some remarkable work on the New York Central road, where it was run for a few trial trips.

PROGRESS IN FLYING MACHINES.

BY O. CHANUTE, C.E.

(*Continued from page* 308.)

THE next apparatus to be noticed was thoroughly experimented with, and years were spent in the endeavor to put it into practical operation. It was first patented by M. *Felix du Temple*, a French naval officer, in 1857, and is shown in fig. 41; the top figure representing an end view from the rear and the lower figure being a top view. It consisted in two fixed wings of silk fabric, stretched by curved spars of wood or metal, and firmly attached to a car containing the motor. In front of this a screw was attached with a pivoted axle, in order to draw the apparatus forward. An horizontal tail hinged at the car was to regulate the angle of incidence and of flight of the machine, while a vertical rudder under the tail and separate from it was to steer to the right or left.

The car was to be shaped like a boat, lightly constructed of wood or iron ribs, and might be covered on the outside with tarred or rubber cloth. Beneath it were to be hinged three hollow legs, which might either be folded up or allowed to hang down. Strong springs inside of them were to carry rods or feet, at the outer end of which were to be wheels to roll over the ground. These legs were to be so adjusted in length that the apparatus should present an angle of incidence of about 20° to the horizon, and upon being put into forward motion, at the rate of about 20 miles per hour by the screw, it was expected to rise upon the air and to enter upon its flight, the latter being regulated by the horizontal tails and by the vertical rudder.

The motor might be steam, electricity, or some other prime mover, and it was estimated that 6 H.P. would be required for an apparatus; weighing one ton. This was a very great underestimate, for the proposed plan of driving the machine over the ground by means of the aerial screw would largely increase the resistance, and sufficient speed could not be obtained to rise upon the air.

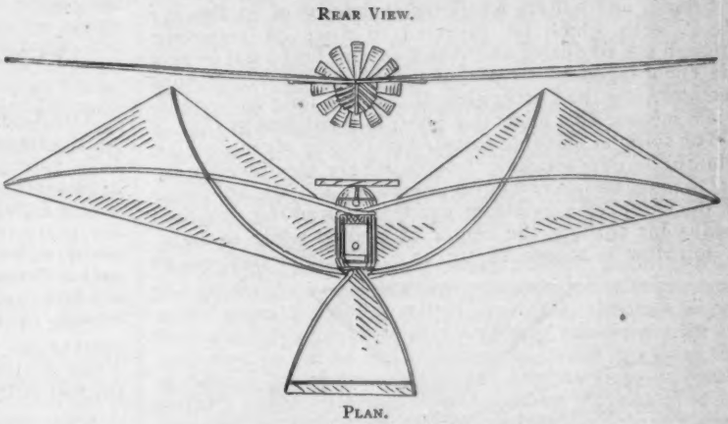


FIG. 41.—DU TEMPLE—1857–1877.

M. *Du Temple* tried many experiments with models shaped like birds, and his patent indicates that he had carefully considered the question of stability, for he places the preponderance of weight toward the front of the car, provides for a diedral angle during flight by the flexibility and shape of the wings, and produces a slight turning up of the rear edge by making it flexible, all much as in the paper aeroplane which has been described. There was a weak point, however, in the fact that the center of gravity was not adjustable during flight, so as to correspond with the change in the center of pressure, produced by such alterations in the angle of incidence as might result from the action of the tail or otherwise.

When he began with the aid of his brother, M. *Louis du Temple*, to experiment on a large scale, the inadequacy of all motors then known became apparent. They first tried steam at very high pressures, then a hot-air engine, and finally built and patented, in 1876, a very light steam boiler weighing from 39 to 44 lbs. to the horse power, which appears to have been the prototype of some of the light boilers which have since been constructed. It consisted in a series of very thin tubes less than ¼ in. in internal diameter, through which water circulated very rapidly, and was flashed into steam by the surrounding flame.

This is understood to have been applied to a slightly modified form of the main apparatus, built in 1874 at Brest by M. *Du Temple*. This was calculated to carry a man, was 40 ft. across from tip to tip, weighed about 160 lbs., and cost upward of $6,000, the workmanship being very fine.

Careful search by the writer through various French and English publications has failed to discover any ac-

count of the operation of this machine, save the statement of M. *Tissandier* that "notwithstanding most persevering efforts, no practical results could be obtained in experimenting with this apparatus."

In 1858 *Jullien*, a French clock repairer of Villejuif, who had already exhibited in 1850 the first model of a fish-shaped navigable balloon which operated with its own motor, propeller, and steering gear, endeavored to prove what could be accomplished with aeroplanes. He exhibited to the French Society of Encouragement for Aviation a model weighing only 1¼ oz., although its aeroplane measured 39 in. across the line of motion. It was propelled by two screws each with two arms, and the power was furnished by the tension of a rubber band wound over two conical spools of equal diameter, like the *fusée* of a watch, in order to maintain the force uniform. The angle of incidence was about 10°, and the apparatus proceeded horizontally in a straight line a distance of 40 ft. in five seconds, with an expenditure of 0.52 foot-pounds per second.

Jullien proposed to build a large apparatus upon the same principle, but he failed to obtain the requisite financial backing. He saw, clearly enough, that he must have a light motor, and he began to experiment with electricity, seeking chiefly a light primary battery. In 1866 he announced that he had succeeded in devising an electric motor and battery weighing at the rate of 82 lbs. per H. P. with which he expected to drive an aeroplane through the air during an entire day; but he did not receive the encouragement or aid of capital, and this ingenious inventor, who had struggled all his life long with inadequate means, died miserably poor, in a hospital in 1877.

The singular machine patented in 1860 by Mr. *Smythies*, while quite impracticable in form, is here mentioned in order to make known two novel proposals—*i.e.*, the utilization of the aeroplanes as steam condensers and the proposed means for shifting the center of gravity while in flight. A top view is shown by fig. 42. The apparatus was to

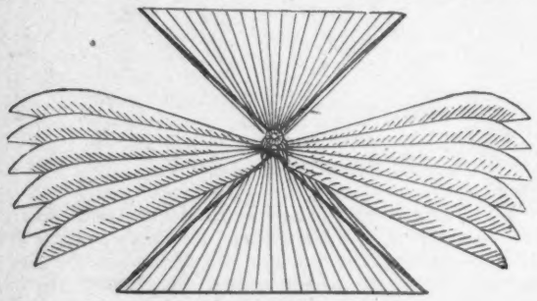


FIG. 42.—SMYTHIES—1860.

consist of extended plane surfaces in order to furnish the support, and to be propelled by the alternating motion of wings actuated by a boiler and engine of a peculiar kind.

The boiler was to be upright, its top view being indicated by the circles at the junction of the two planes. It was to be fitted with small vertical water-tubes, thickly placed in a "flame-chamber" heated by the combustion of some volatile fluid mixed with air. Back of the boiler an upright cylinder was to be placed to work the wings up and down, feathering motion being imparted to the vanes composing them (by compound levers), so that they should separate slightly on the up-stroke and firmly close on the overlap on the down-stroke.

The whole of the two aeroplanes and of the upright boiler was to be encased in a closed flat bag of oiled silk or other light air-tight covering—that is to say, that a steam surface condenser was to be provided by making a hood, tapering on its top and bottom from the thin edges at the front and rear of the apparatus to a thickness at the center equal to the height of the boiler. This hood or case was to be kept distended by spars and by light cords, and the spent steam was to be exhausted therein so as to be condensed by contact with the sides, and the water thus produced was to drain into a reservoir at the bottom, whence it was to be pumped back into the boiler, thus keeping the total weight of the apparatus constant and utilizing the same water over and over again.

The operator was to be suspended in an adjustable seat beneath the center of gravity of the machine, and by shifting his position sideways or fore and aft, was to guide the machine to the right or left, or up and down through the changes thus produced in the position of the center of gravity and consequent angle of incidence. Elastic legs beneath the whole were to break the fall on alighting; the descent being, moreover, retarded by the action of the wings, in which both the amplitude of movement and the overlap of the vanes or "feathers" were under the control of the operator through a series of cords.

This apparatus as designed was quite impracticable, but it indicates that the inventor had been watching the birds and had become aware of some requirements overlooked by his predecessors, such as the necessity for adjusting during flight the center of gravity to coincide with the center of pressure consequent upon changes in the angle of incidence, in order that the equilibrium may be preserved; the necessity for more energetic efforts and greater angles of incidence at starting and in alighting than during horizontal flight, and also the necessity for an air condenser to liquely the steam, if the latter is to be used as a motive power, both to diminish the weight of the water required and to keep the weight constant.

(TO BE CONCLUDED.)

LEGISLATION ON SAFETY APPLIANCES.

THE Committee on Interstate Commerce of the House of Representatives has presented a report on the various bills submitted to it relating to the adoption of safety appliances on the railroads subject to the Interstate Commerce Law. The report discusses the demand submitted for protection by railroad employés, the nature of accidents as indicated by the report of the Interstate Commerce Commission, and the apparent inability of the railroads to agree upon the proper remedy, and ends by submitting to the House a bill intended to take the place of the various measures which were before the Committee. From its importance it has been considered best to give the text of this bill in full.

A BILL to promote the safety of employés and travelers upon railroads by compelling common carriers engaged in interstate commerce to equip their cars with automatic couplers and continuous brakes and their locomotives with driving-wheel brakes, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, that on and after the first day of July, 1893, it shall be unlawful for any common carrier engaged in interstate commerce by railroad to put into use on its line any new locomotive to be used in moving interstate traffic that is not equipped with power driving-wheel brakes.

SEC. 2. That from and after the first day of July, 1895, it shall be unlawful for any such common carrier to use on its line any locomotive engine in moving interstate traffic that is not equipped with a power driving-wheel brake so arranged as to be operated in connection with the train-brake system.

SEC. 3. That on and after the first day of July, 1895, it shall be unlawful for any such common carrier to use on its line for the purpose of moving interstate traffic any new car or any old car that has been to the shops for general repairs to one or both of its draw-bars that is not equipped with automatic couplers of the standard designated under and in accordance with the provisions of this act.

SEC. 4. That on and after the first day of July, 1898, it shall be unlawful for any such common carrier to haul or permit to be hauled or used on its line any car used in moving interstate traffic unless such car is equipped with automatic couplers of the standard designated under and in accordance with the provisions of this act.

SEC. 5. That on and after the first day of July, 1895, no such common carrier shall put into use or haul or permit to be hauled on its line for the transportation of interstate freight traffic any new car belonging or leased to it or any old car belonging or leased to it which subsequently to the passage of this act has been sent to its shops for general repairs, unless such car is equipped with brakes for each wheel and with train-brake apparatus of such a nature that the brakes can be set and released from the locomotive.

SEC. 6. That on and after the first day of July, 1898, no such common carrier shall haul or permit to be hauled on its line for the transportation of interstate freight traffic any car which is not equipped with brakes for each wheel and with a train-brake apparatus of such a nature that the brakes can be set and released from the locomotive.

SEC. 7. That on or before the first day of July, 1893, every such common carrier shall file with the Interstate Commerce Commission in Washington a statement certified to under oath by the president and clerk of the corporation, as the action of said corporation through its board of directors, setting forth such details with reference to the height, form, size, and mechanism of freight car couplers as it deems essential in order to insure requisite uniformity, requisite automatic action, and requisite safety in service, and also stating the number of freight cars owned by it and under its control, and also the number of other cars under its control by lease on the thirtieth of June, 1892, exclusive of those used solely for state traffic. Such statements shall be made upon blanks to be provided by the Interstate Commerce Commission, and the determination of such commission in relation to the validity of the several statements received shall be final. If upon examining the statements so received said Interstate Commerce Commission is of opinion that companies owning at least 75 per centum of the freight cars owned and controlled as aforesaid by companies which shall have duly filed statements as aforesaid have agreed upon such details of freight-car couplers as will insure requisite uniformity, requisite automatic action, and requisite safety in service, said Commission shall thereupon declare and publish that couplers complying with such details so agreed upon shall thereafter, until otherwise ordered according to law, be the standard couplers for use in the freight-car interstate service. If the common carriers shall fail to establish a standard coupler as herein provided, then the standard automatic coupler shall be such coupler as shall be selected by the Interstate Commerce Commission; and it is hereby made the duty of said Commission, within six months after the first day of July, 1893, to select and designate some automatic coupler as a "standard type," under the provisions of this act, and to promulgate notice of such selection.

SEC. 8. That after July 1st, 1898, any such common carrier may refuse to accept or receive any car used in interstate commerce that is not properly equipped as required by this act, and the carrier loading or starting such car shall be liable for the damages if any result therefrom.

SEC. 9. That from and after the first of July, 1893, until otherwise ordered by the Interstate Commerce Commission, it shall be unlawful for any railroad company to use any car in interstate commerce that is not provided with secure handholds in the ends and sides of each car.

SEC. 10. That within 90 days from the passage of this act the American Railway Association is authorized hereby to designate to the Interstate Commerce Commission the standard height of draw-bars for freight cars, measured perpendicular from the level of the tops of the rails to the centers of the draw-bars, and shall fix a maximum variation to be allowed between the draw-bars of empty and loaded cars. Upon their determination being certified to the Interstate Commerce Commission, the Commission shall give notice of the standard fixed upon, at once, to all common carriers, owners, or lessees engaged in interstate commerce in the United States by such means as the commission may deem proper, and thereafter all cars built or repaired shall be of that standard. But should said Association fail to determine a standard as above provided, it shall be the duty of the Interstate Commerce Commission to do so. And after July 1st, 1893, no cars shall be used in the interstate traffic which do not comply with the standard above provided for, either loaded or unloaded.

SEC. 11. That an employé of any such common carrier who may be injured by any locomotive, car, or train in use contrary to the provisions of this act shall not be deemed guilty of contributory negligence, although continuing in the employ of such carrier after habitual unlawful use of such locomotive, car, or train had been brought to his knowledge.

SEC. 12. That any such common carrier violating any of the provisions of this act shall be liable to a penalty of $100 for each and every such violation, to be recovered in a suit or suits to be brought in the district court of the United States having jurisdiction in the locality where such violation shall have been committed by the United States district attorney of such district, and it shall be the duty of such district attorney to bring such suits upon duly verified information being lodged with him of such violation having occurred. And it shall also be the duty of the Interstate Commerce Commission to lodge with the proper district attorneys information of any such violations as may come to its knowledge.

This bill is now on the calendar of the House, but the condition of business is such that it will hardly be acted on at the present session, and will probably go over to next winter's session.

ACCIDENTS AND LONG HOURS OF WORK.

AN investigation into the hours of labor required from railroad employés in England is now in progress; and a recent number of the London *Times* reports some interesting testimony given before the Parliamentary Committee by Major Marindin, who has been for a number of years Inspector of Railroads for the Board of Trade. In this connection it might be suggested that there are cases in this country where an investigation might show some connection between accidents and the fatigue due to long hours of work. The substance of Major Marindin's testimony is given below:

Major Marindin stated that it was part of his duties to inquire into and report upon train accidents. Since the date of his appointment he had held 429 inquiries himself, and during the years 1888, 1889, 1890 and 1891 there were held by the three inspecting officers 257 inquiries. During the last four years he had had on 23 occasions to call attention to the fact that the hours of work of some of the men were excessive. In addition to the accidents which he himself had called attention to, other inspecting officers had called attention on 24 occasions to the long hours of work, and upon 11 occasions they had reported that the servant held responsible for the accident, or partially so, had worked very long hours; upon nine occasions the accident had been attributed to some extent to these long hours of work. On the last occasion, when he investigated an accident on the Lancashire & Yorkshire Railroad, he drew attention to the fact that one of the men engaged at the time had been on duty fifteen hours. With regard to the necessity or practicability of legislation with reference to the hours of work of railroad servants, although he was very strongly of opinion that very long hours were an evil and must be put an end to somehow, he did not think that at present it was desirable to put any statutory limitation to their hours. He would rather leave the matter to the force of public opinion, which certainly did have a great effect on the companies. No Board of Directors could afford to disregard the strong opinion that had been expressed as to the evil of long hours, especially if the Committee were to report in the same sense. The railroad companies in the past had not done what they might have done to keep the hours of work within a reasonable limit, but of late there had been an improvement, as was shown by the returns which had been put in by the Secretary of the Railroad Department of the Board of Trade. Railroad managers would, he hoped, in future recognize the bad economy of overworking their servants. He thought the moral effect of a censure from the Board of Trade would be considerable, although the Board was allowed no legal power in the matter. Owing to the enormous variety of circumstances under which railroad servants worked, it would be almost impossible to lay down any hard-and-fast rule as to the hours of work. For instance, ten hours a day would be quite enough for an express driver, but he could easily conceive a case on a branch line with a shuttle traffic, where a driver doing thirteen hours, owing to frequent intervals of rest, would have a comparatively easy time compared with the man who was constantly driving for eight or nine hours. In the case of signal-men it was almost impossible to fix whether a signal-box should be an eight, ten, or twelve hours' box, except by considering each case on its merits. In a box of the Underground Railroad, for instance, there were really only six or eight levers, but the number of trains passing was so great that the signalman had never any rest at all, and the strain upon him was immeasurably greater than it was upon a man in a box on another line containing, perhaps, five times that number of levers. He did not think signal-men should work more than eight or ten hours. It was not a common thing for these men to work over twelve hours; but sometimes men for their own convenience, when in twelve-hour

LOCOMOTIVE RETURNS FOR THE MONTH OF APRIL, 1892.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage.					Av. Train.		Coal Burned per Mile.						Cost per Locomotive Mile.							Cost per Car Mile.		Cost of Coal per Ton.
			Passenger Trains.	Freight Trains.	Service and Switching.	Total.	Average per Engine.	Passenger Cars.	Freight Cars.	Passenger Train Mile.	Freight Train Mile.	Service and Switching Mile.	Train Mile, all Service.	Passenger Car Mile.	Freight Car Mile.	Repairs.	Fuel.	Oil, Tallow and Waste.	Other Accounts.	Engineers and Firemen.	Wiping, etc.	Total.	Passenger.	Freight.	
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Alabama Great Southern	....	56	53,688	79 912	39,501	173,101	3,091	....	....	58.48	92.59	37.37	69.93	...	...	5.60	4.70	0.24	0.40	6.30	1.80	19.14	...	...	....
Alabama & Vicksburg	....	15	17,565	14,911	11,136	43,612	2,907	....	....	52.08	103.63	57.31	71.17	....	....	5.60	6.40	0.33	0 60	6.10	1.80	20.63	....	....	....
Atchison, Topeka & Santa Fé	834	724	.....	.....	317,832	2,075,424	2,867	....	....	...	....	....	82.29	....	....	4.77	6.64	0.28	0.13	6.52	1.36	19.70	....	. ..	1.52
Canadian Pacific	593	...	480,127	786,365	310,790	1,577,282	2,655	. ..	....	....	....	...	67.02	....	...	3.95	11.90	0.43	....	5.37	1.05	23.05	....	1.97	3.49
Chic., Burlington & Quincy	505	....	.....	.....	.....	1,652,702	3,253	4.90	17.72	....	....	....	84.21	....	....	4.92	5.80	0.21	0.32	6.97	...	18.22	....	...	1.36
Chic., Milwaukee & St. Paul	804	....	.....	. .....	..... .	2,350,845	2,924	....	....	....	....	....	73.34	....	.	5.16	7.55	0.28	...	7.00	....	19.99	....	....	2.00
Chicago & Northwestern	856	....	658.324	1,259,072	657,205	2,574,601	3,008	....	....	....	....	....	86.02	....	....	3.62	7.90	0.36	....	6.30	0.88	19.06	....	....	1.81
Cincinnati Southern	....	100	77,669	160,074	75,761	313,504	3,135	. ..	.. .	61.54	125 00	34.96	89.19	....	....	3.70	6.00	0.28	0.50	6.40	1.70	18.58	....	....	...
Cleve., Cinn., Chic. & St. L	....	428	403,651	565,158	339,771	1,308,580	3.058	4.30	21.0	73.67	114.02	70.82	90.33	17.13	5.43	3.36	5.80	0.18	1.95	6.36	0.25	17.90	.. .	....	1.28
Cumberland & Penn	22	22	4,970	28,242	.....	33,212	1,510	....	....	....	....	....	84.74	.. .	...	6.14	4.80	0.40	...	....	1.80	13.14	....	....	....
D., L. & W., Morris & Essex Div	156	...	162,416	254,010	12,673	426,099	2,732	....	....	..	....	....	62.73	....	....	4.11	9.78	0.35	....	6.16	....	20.40	....	....	3 08
Hannibal & St. Joseph	41	37	44,484	74,121	20,278	141,883	3,835	4.99	15.67	....	...	....	82.64	14.66	6.53	3.97	5.17	0.15	0.26	6.59	...	16.14	....	....	1.32
Kan. City, F. S. & Mem	150	....	98,652	222,970	107,620	492,242	2,861	....	....	.. .	....	....	61.71	....	...	4.21	5.45	0.16	0.55	7.44	....	17.81	....	....	1.71
Kan. City, Mem. & Birm	41	39	47,078	49,607	17,078	93,763	2,404	...	....	...	....	....	54.39	....	....	2.65	3.29	0.20	0.52	7.05	....	13.77	....	....	1.14
Kan. City, St. Jo. & Council Bluffs	44	42	60,515	39.066	38,033	137,614	3,276	4.74	20.02	....	...	....	61.80	13.76	4.45	5.58	4.94	0.10	0.18	5.83	....	16.63	....	....	1.88
Lake Shore & Mich. South	587	....	415,863	766,501	573,095	1,755,459	2,991	....	....	61.08	85.36	36.20	63.77	....	....	3.13	5.11	0.18	....	6.91	0.19	15.52	....	....	1.59
Louisville & Nashville	....	*342	420,140	766,833	373.909	1,560,882	3,471	4.96	15.87	62.64	108.16	60.44	80.54	12.69	6.72	5.03	6.53	0.27	1.49	6,12	0.65	20.09	3.33	1.58	1.62
Manhattan Elevated	....	291	765.913	.....	64,845	830,758	2,855	..	....	....	....	....	43.67	....	....	2.50	8.80	0.30	....	8.70	....	20.30	...	...	4.03
Mexican Central†	146	118	.....	..... .	.....	362,194	3,069	....	.. .	...	....	....	61.05	....	....	5.68	15.35	0.40	0.15	5.92	1.01	28.55	....	....	5.60
Mil., L. S. & West	112	104	75,981	157.257	86,098	319,336	3,071	....	....	...	....	....	78.64	....	....	4.46	11.75	0.24	....	6.15	0.96	23.56	....	....	3.00
Minn., St. P. & Sault Ste. Marie	....	....	62,257	137,182	33,825	233.264	.....	4.87	17.24	...	....	...	66.78	....	....	3.72	11.16	0.21	....	6.34	...	21.43	....	1.86	4.17
Missouri Pacific	339	304	.....	.....	.....	1,036,496	3,406	4.30	16.16	....	....	....	80.58	18.41	5.67	4.67	5.76	0.34	1.19	6.48	1.51	19.96	4.73	1.37	1.41
N. O. & Northeastern	.. .	27	26,303	37,991	21,335	86,229	3,194	....	....	63.09	114.93	31.95	71.17	....	....	4.50	7.40	0.28	0.60	6.20	1.70	20.68	....	....	....
N. Y., Lake Erie & West	622	....	431,289	957,827	275,590	1,664,706	2,676	4 60	22.20	87.10	128.90	69.10	....	18.70	5.80	4.06	7.04	0.40	2.28	7.10	1.11	21.99	....	1 57	1.30
N. Y., Pennsylvania & Ohio	263	....	138,404	441,891	134,631	714,926	2,718	5.30	18.20	84.30	137.80	77 80	....	16.00	7.60	3.32	6.75	0.31	1.67	6.81	0.98	19.84	...	1.61	1.15
N. Y., Prov. & Boston	....	89	105,509	47.912	58,170	211,600	2,378	....	...	...	...	....	52.31	....	....	2.61	10.01	0.55	....	6.19	0.88	20 24	....	....	....
Norfolk & Western, Gen. Eastern Div.‡	....	131	97,320	232,670	70,625	400,616	3,057	4.40	19.80	...	....	....	100.00	....	...	6.80	4.10	0.80	....	....	....	11.70	....	....	....
Durham Division‡	....	6	7,182	9,934	4,343	21,459	3,577	4.90	4.70	...	....	....	51.54	...	...	2.20	7.20	0.40	....	....	....	9.80	....	....	....
Radford Division‡	....	50	16,326	111,902	9,292	137,520	2,750	5.20	17.90	....	....	....	139.23	....	...	11.80	5.50	0.80	....	....	....	18.10	....	....	....
Pulaski Division‡	....	28	26,447	46,243	8,221	80,911	2,890	4.90	17.70	....	....	....	101.52	....	....	5.70	4.10	0.80	. .	...	....	10 60	...	....	....
Clinch Valley Division‡	....	40	20,341	52.448	17,423	90,212	2,255	3.80	10.70	....	....	....	125.00	....	....	9.10	5.00	1.00	...	...	....	15.10	...	....	...
Ohio & Mississippi	112	....	131,647	146,800	87,703	366,152	3,269	..	....	....	....	....	80.97	....	....	4.10	3.53	0.26	1.21	5.47	1 48	16.05	....	....	0.84
Old Colony	....	213	307,961	126,411	118,877	553,249	2,397	....	....	....	....	....	57.44	....	....	4.00	10.77	0.64	. ..	6.85	0.83	23.09	....	....	3.75
Philadelphia & Reading	....	....	440,840	388,852	515,582	1,645.274	....	....	....	....	.. .	....	81.67	....	. ..	4.53	4.65	0.35	....	5.76	0.42	15.71	.. .	...	....
South. Pacific, Pacific Sys	701	....	.....	....	.....	1,571,383	2,242	....	....	....	....	....	67.70	...	....	5.48	18.66	0.38	1.81	7.27	1.90	35.50	..	....	5.70
Union Pacific	992	....	709,971	1,162,322	486,802	2,359,102	2,378	5.55	16.13	...	....	..	100.60	15.63	8.44	8.02	10.15	0.44	0.96	8.07	1.25	28.89	4.70	2.26	2.01
Vicksburg, S. & P	....	14	11,568	8,816	9,902	30,286	2,163	....	.....	47.84	80.32	28.33	53.76	....	....	3.80	7.10	0.30	0.90	6.30	2.60	21.10	....	....	....
Wabash	401	337	395,035	620,511	226,698	1,242,244	3,686	4.95	17.30	....	..	....	83.02	13.44	6.03	3.30	4.83	0.29	....	6.22	0.89	15.53	2.68	1.03	1.16
Wisconsin Central	152	143	124.889	223.486	66.984	415.350	2,905	....	....	..	....	....	81.93	...	....	3.42	9.73	0.24	....	7.30	....	20.69	....	...	2.31

NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars.

* Number of engines in revenue service only; average mileage is also based on revenue service.

† The Mexican Central Railroad reports 17.2 units of work per $1 of expense; 177.5 units of work per ton of coal; 11.3 lbs. of coal per unit of work. The unit of work is 100 gross tons hauled one mile in one hour on a straight and level track.

‡ Wages of engineers, firemen, and wipers not included in cost.

boxes, preferred to work thirteen hours night shift and eleven on a day, changing about. The work of station-masters and porters varied very much. At a large station it was so excessive that they were not called upon to work long hours, but at small roadside stations the hours were longer, though there were more intervals of rest. With regard to these intervals of rest, he did not think a short interval was worth much, although the aggregate might amount to several hours, but a rest of four hours would be worth a good deal if the man could get away from his engine or train.

He was in favor of the Board of Trade using all the powers they had got to bring about a reduction in the hours of work.

The number of cases of accident where the Board of Trade had ascertained that the railroad servants had been employed very long hours when the accident occurred was ten in 1888; eleven in 1889; fifteen in 1890, and twelve in 1891.

UNIFORM REPORTS OF LOCOMOTIVE PERFORMANCE.

THE following is the report submitted to the Master Mechanics' Association by the Committee on Uniform Reports of Locomotive Performance; it is signed by Messrs. George F. Wilson, J. S. McCrum, John Player, James McNaughton and John A. Hill:

Your Committee, appointed to investigate the subject of uniform locomotive performance statement, beg to submit the following:

First. We would recommend that all passenger and freight mileage be based on actual miles run, and 5 per cent. to be added to all freight mileage; that all engines in construction or snow-plow service be allowed at the rate of 10 miles per hour; all engines in switching service be allowed at the rate of 8 miles per hour, no percentage to be added to this class of mileage. All other runs of less than 100 miles, freight or passenger, actual miles to be allowed, regardless of what engineers and firemen may be paid for such service. No extra mileage should be allowed going to and from the round-house. When an engine is assigned to more than one class of service, the mileage should be computed, so as to show each class of service.

Second. In the distribution of fuel one cord of wood should be rated as one ton of coal, and all expense in connection with the handling of fuel, either wood or coal, to be included in the cost of same; all coal to be rated at 2,000 lbs. per ton.

Third. In the distribution of illuminating oils, only such oils as are used in the head-lamps and lamps and torches belonging to engines should be shown on the performance sheets.

In the distribution of lubricating oils, we believe all oils used in lubricating engine, including that used in packing driving-boxes, tender, and engine trucks, while engine is undergoing general repairs, should be charged to repairs. All lubricating oils used on engine after engine goes into service, to be charged on cost and performance sheets as lubricating oil against engine.

Fourth. In showing the miles run to one pint of oil, the engine, valve, and illuminating oil should be separated, showing the miles run to one pint of each, and a separate column be made on engine's statement, giving the total average for all kinds of oil.

All waste used by engineers and firemen, and by wipers for wiping engines, should be shown on performance sheet, and the miles run to one pound of waste given. Waste used on engines while undergoing repair should be charged to repairs.

Fifth. In the apportionment of the expense of labor for repairs of engines, we believe no labor should be charged for repairs other than performed by mechanics, helpers, and those actually working on repairs; laborers, sweepers, sanding and turning table, cleaning round-house and other outside work in and about round-house, should not be charged to repairs, but should be charged to locomotive service.

All undistributed labor, such as superintendence, clerks, etc., should be prorated over general shop expense. Cost of engine repairs, caused by accident due to other than engine failures, to be not shown on performance sheet, but such expense should be kept separately, and charged to the department responsible for the accident.

Sixth. All new engines purchased or built to take the place of those worn out should not be charged to repairs of locomotives. All general repairs of engines, including overhauling, etc., except the above-mentioned, to be charged to repairs, except the application of new devices, such as air-brake equipment, extension front end, steam-heating appliances, train signal, or smoke consumer. We believe the application of these new devices should be charged to new equipment or betterment. In the charges for materials used on engines, including files, chisels, other small tools, and the engine's equipment, should be charged to repairs of engines. We would recommend the preparation each month of a performance sheet in detail for each division of the road, the same to contain the following information:

Engine No.
Name of engineer.
Name of fireman.
Mileage, each class separately.
Mileage, total.
Tons of coal.
Cords of wood.
Oil, each kind separately.
Waste, pounds.
Cost of coal.
Cost of wood.
Cost of oil and waste.
Wages of engineer and fireman.
Wages of hostler, wiper, and miscellaneous labor.
Cost of material for repairs.
Cost of labor for repairs.
Cost, total.
Cost per mile run for fuel.
Cost per mile run for oil and waste.
Cost per mile run for engineer and fireman.
Cost per mile run for hostlers, wipers, etc.
Cost per mile run for repairs, labor, and material separately.
Total cost per mile run.
Miles run to one ton of coal.
Miles run to one pint of engine oil.
Miles run to one pint of valve oil.
Miles run to one pint of lubricating oil.
Miles run to one pint of illuminating oil.
Miles run to one pint of all kinds of oil.
Miles run to one pound of waste.
Average number of loaded cars hauled per train.
Average number of pounds of coal consumed per car per mile.

To place the rating of empty cars on a uniform basis, your Committee would recommend the following:

In figuring loads, all box, stock, refrigerator, and furniture cars, 30 ft. long or over, three empties to be considered equal to two loads; gondola and flat cars, two empties to be considered equal to one load.

The Railroad Puzzle.

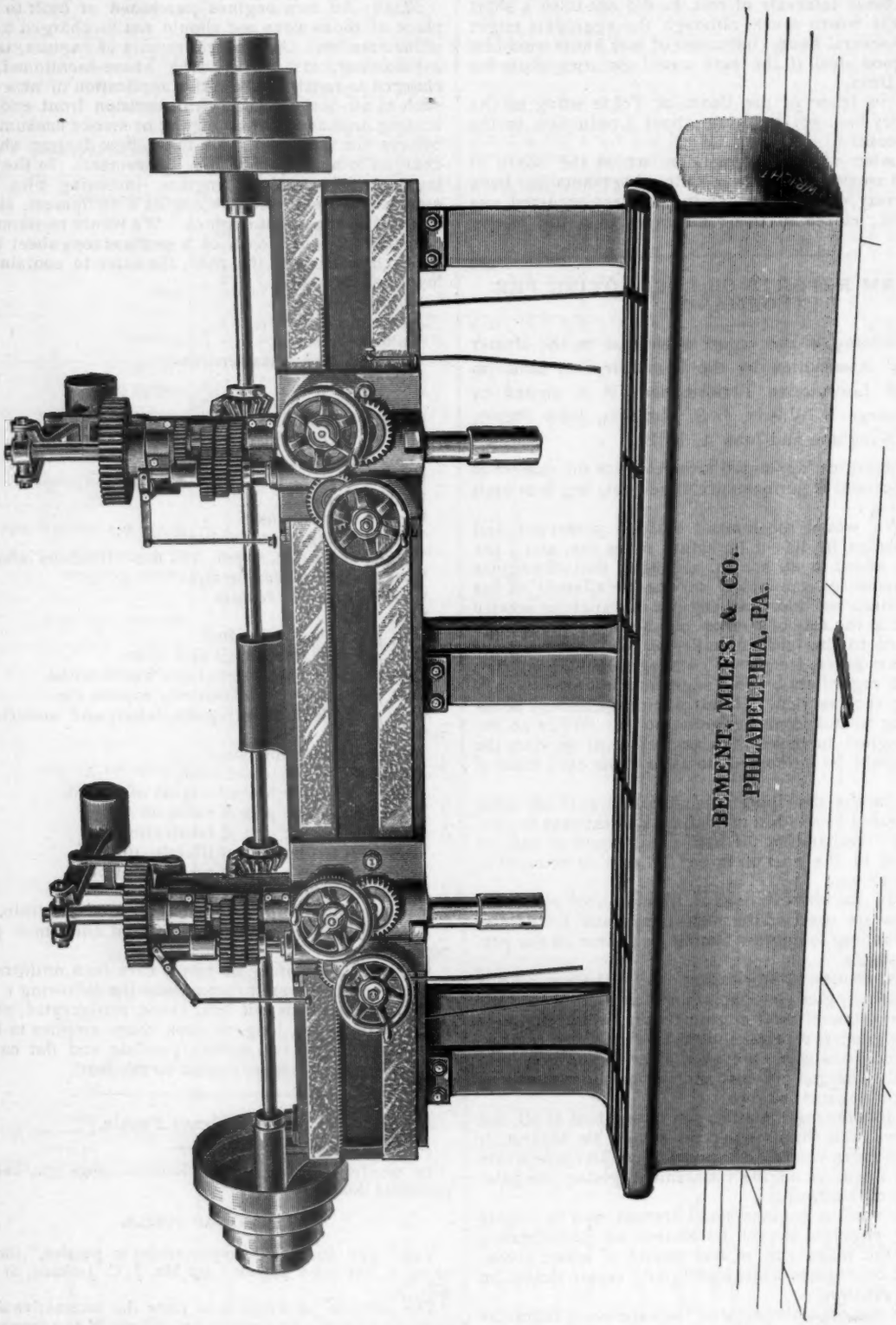
IN the July number of the JOURNAL, page 332, there was published the following:

RAILROAD PUZZLE.

The "new and useful improvement in puzzles," illustrated by fig. 6, has been patented by Mr. J. C. Jackson, of Greenville, Pa.

The problem presented is to place the locomotive and cars as shown, run the locomotive around the Y to reverse it, and leave the cars as they were found—3 at *F*, 2 at *B*, and 1 at *C*.

In the solution of the problem what is known as "running switches" are not allowed. The cars can only be pushed or pulled by the locomotive. Neither can but one car or the locomotive alone be upon the spur *D* at one time. Neither can more than two cars or the locomotive and one car be upon the main track at the left of the Y, as at *E'*, at one time. The

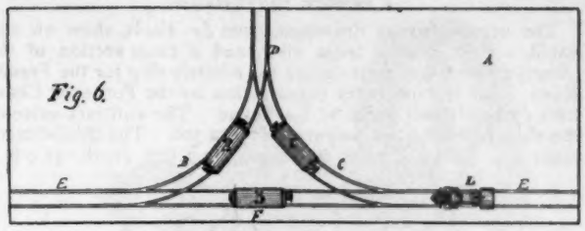


TWO-SPINDLE DRILLING MACHINE FOR LOCOMOTIVE CONNECTING RODS.

MADE BY BEMENT, MILES & COMPANY, PHILADELPHIA.

main track between the branches of the Y will hold the locomotive and one car.

As then promised, we give herewith the solution contained in the specification of Mr. Jackson's patent. We may mention also that correct solutions have been sent in by three subscribers—Mr. Thomas Wright, of Luzerne, Pa.; Mr. Thomas



JACKSON'S RAILROAD PUZZLE.

H. Wigglesworth, of Denver, Col.; and Mr. H. J. Kennedy, of Lutherville, Md.

The answer given by the inventor is as follows:

SOLUTION OF THE PUZZLE.

Place the locomotive and cars as seen in the drawings, the locomotive *L* on the main track *E* at *e* with the pilot pointed toward the Y, car 3 on the main track between the branches *B C* at *f*, car 2 on the branch *B*, and car 1 on branch *C* at *c*. Run the locomotive down the branch *C* and pull car 1 back on the main track and push it down to car 3 on the main track between branches *B* and *C*. Then back the locomotive, run it down branch *C* onto the spur *D* and back up branch *B*, and push car 2 out on the main track at *E'*. Then run the locomotive down the main track, and push cars 1 and 3 out to or beyond *e*. The locomotive then stands on the main track reversed from its first position; but it has yet to make the circuit twice more to complete the solution. Now back the locomotive down branch *C* onto spur *D*, run up branch *B* onto the main track, when the pilot will point in the same direction as when it started first. Then back down the main track and get cars 1 and 3 and pull them on the main track between branches *B* and *C*. Now run on and get car 2 and back with it on branch *B* and leave it there. Then back the locomotive onto spur *D*, run up branch *C* to the main track, back up and get car 1, and pull it out on main track at *e*. Then push said car 1 back on branch *C* and run the locomotive up on the main track, and it is reversed, as desired, and all the cars are left as they were first placed.

New Machine Tools.

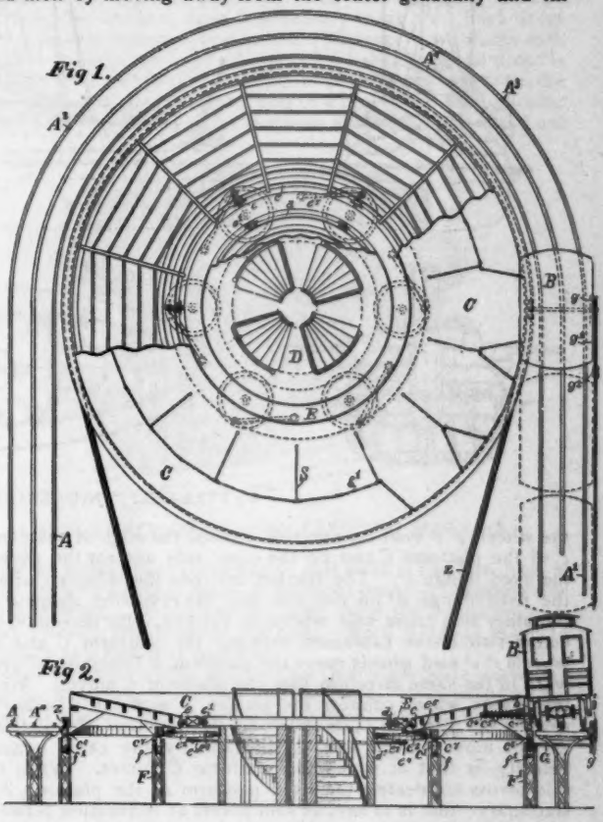
In a previous number some reference was made to the variety of tools made by the works of Bement, Miles & Company in Philadelphia. Among these are included a great number intended for special purposes in locomotive and other shops, and an example of these has been selected for illustration here.

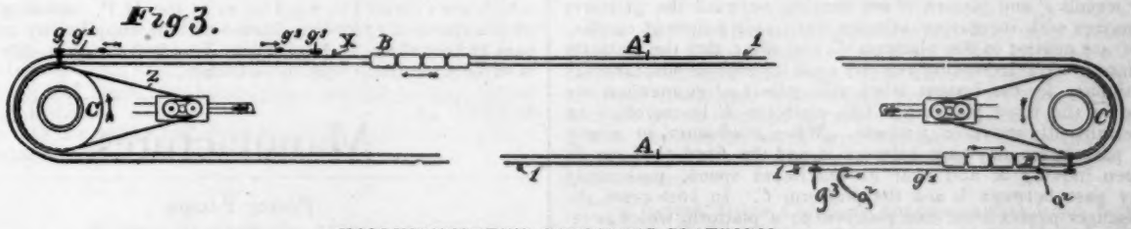
The present engraving shows a special tool which will be very serviceable in locomotive shops. It is a two-spindle drilling machine, designed especially for drilling at one time the holes at both ends of locomotive connecting and parallel rods. It will drill the longest or the shortest rod generally found, the extreme distance between centers being 10 ft. and the shortest distance 3 ft. The power of each head is sufficient to drill a 3½-in. hole in the solid material, and to bore out a 9-in. hole. The spindles are independently driven and have four speeds; three feeds through a distance of 15½ in.; quick return motion; lever counterbalance, and lateral adjustment on the cross-slide by a rack and pinion. Each spindle can be adjusted vertically. The machine is provided with two automatic pumps for lubricating the drills, and the necessary countershafts, etc., are also provided.

Recent Patents.

REVOLVING PLATFORM FOR TRANSFERRING PASSENGERS TO AND FROM MOVING TRAINS.

The possibility of taking passengers on and putting them off of moving trains has been a subject of a good deal of speculation by inventors. Mr. Charles M. Hollingsworth, of Cleveland, O., has recently patented the ingenious method of doing this, which is illustrated by figs. 1, 2, and 3. In his specification he says: "I have based the construction and intended mode of operation of the circular platform as a means for passing to and from a moving train, primarily, in the fact that the angular motion at the center of a revolving circular platform is *nil*, and increases as the radial distance from the center to the circumference increases. A body supported in such a platform gradually acquires tangential motion in moving toward the circumference, and gradually loses tangential motion in moving toward the center of rotation. Thus we may, if suitable means are provided, get onto a revolving circular platform near the center of rotation without material disturbance to one's balance, and then by moving away from the center gradually and imperceptibly acquire the greater movement of the outer edge of the platform.





HOLLINGSWORTH'S REVOLVING PLATFORM.

"As shown in figs. 1 and 2, the platform *C* is in the form of a ring, which surrounds a central stationary platform, *D*. Both platforms are elevated, and a person may reach the stationary platform by passing under the moving platform to stairs which lead to the stationary platform. The platform *C* has on its under side and near its outer and inner edges, respectively, the circular beams c^1 c^2, which serve as tracks and rest upon the friction-rollers *f f'*, which are mounted on the columns *F F'* arranged in circles about the axis of rotation. The platform is revolved by the driven cable *Z*, which lies in a peripheral groove, or by any other appropriate mechanism.

"Intermediate of the stationary platform *D* and the revolving platform *C* is an intermittently movable ring-shaped platform *E*. On both the outer and inner edges of the platform *E* is mounted a series of rollers or wheels *e e'*, which rest, respectively, on the flange *c* on the platform *C* and the flange *d* on the platform *D*. By these means the platform *E* is supported with its upper surface at the level of the proximate edges of the platforms *C* and *D*.

"A series of horizontal wheels e^2 e^2, each having a flange e^3, which rests upon flanges *c'* on the platform *C* and d^2 on the frame of the platform *D*, is loosely journaled to a stiff ring e^4. This ring is sustained by its connection with the wheels, and the only function of the ring, as shown in the drawings, is to keep the wheels e^2 e^2 properly spaced at the same distance from each other. Each wheel is connected by means of a pitman, e^5, with the under side of the platform *E*. The faces of the wheels e^2 e^2 bear on one side against the edge of the flange *c'* of the platform *C* and on the other side against the edge of the fixed flange d^2. The friction between the wheels e^2 e^2 and the fixed flange d^2 on one side and the revolving flange *c'* on the other side cause said wheels to revolve. By reason of the connection above explained between the platform *C* and the wheels e^2 e^2 said wheels move the platform *E* intermittently forward in the same direction that the platform *C* moves. When the pivots which connect the pitmen e^5 with the wheels e^2 is nearest the platform *C*, as shown in the drawings, the platform *E* will move fastest and at substantially the same angular velocity as that at which the platform *C* moves. When the said pivots are nearest the fixed platform *D*, the platform *E* is stationary—that is to say, as said points of connection between the wheels e^2 and pitmen e^5 are moving outward the platform *E* moves with increasing velocity until said points of connection are nearest to the platform *C*, and after that the platform *E* moves with decreasing velocity until it becomes substantially stationary for the instant when said points of connection are nearest the fixed platform. The platform *E* is therefore an intermittently movable platform. When stationary, or nearly so, passengers may pass between it and the fixed platform *D*. When moving at and near its maximum speed, passengers may pass between it and the platform *C*. In both cases the passenger passes from one platform to a platform which is relatively fixed, or substantially so."

Fig. 3 shows the arrangement of the tracks in relation to the platforms.

Foreign Naval Notes.

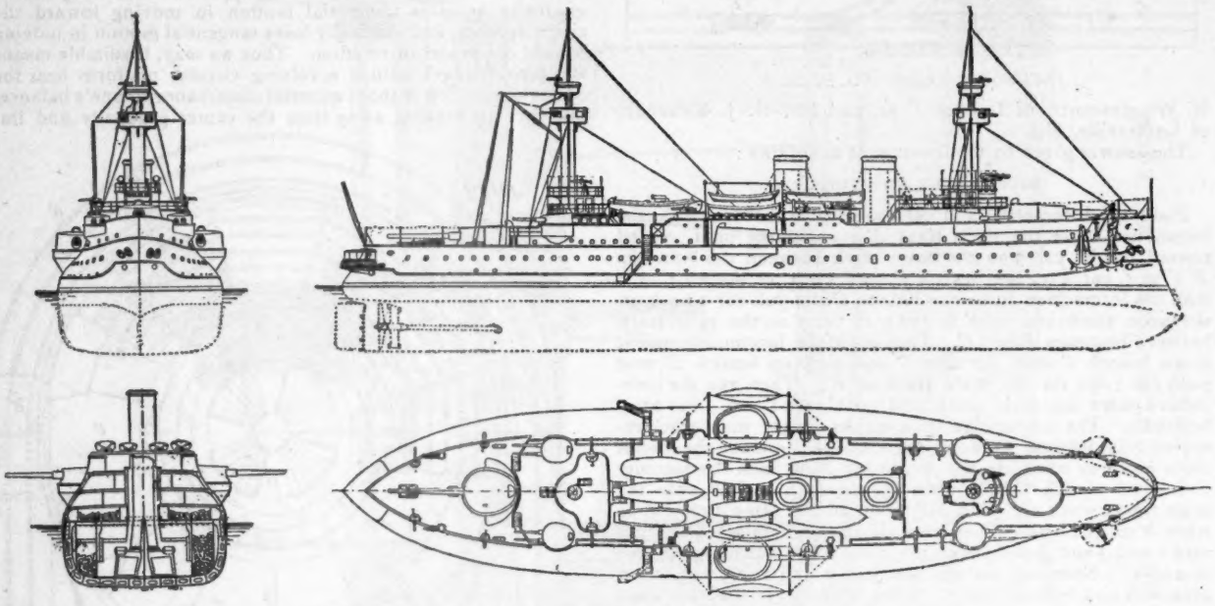
A SPANISH TORPEDO-CRUISER.

THE Spanish torpedo-cruiser *Temerario* was recently completed at Cartagena; she was designed by Don Tomas Tallerie, and is the first of six of the same class, two of the others being now under construction at Carraca and three at Ferrol. The dimensions of the *Temerario* are: Length, 190 ft.; beam, 23 ft.; extreme draft, 10 ft. 4 in.; displacement, 550 tons. She has two torpedo-tubes, and also carries two 12 cm. (4.7-in.) Hontoria guns, four 2.2-in. and one 1-in. Nordenfelt guns.

There are two triple-expansion engines, built by Maudslay, Sons & Field, in London, England. There are two cylindrical boilers and two boilers of the locomotive type. On her trial trip the highest speed with forced draft was 20,5 knots; the average speed with natural draft was 16.5 knots.

A FRENCH BATTLE-SHIP.

The accompanying drawings, from *Le Yacht*, show an elevated, a deck plan, a front view, and a cross-section of the *Jauréguiberry*, the latest design for a battle-ship for the French Navy. She is now under construction by the Forges et Chantiers de la Mediterranée, at La Seyne. The contract price of the ship, including armament, is $5,172,300. The chief dimensions are: Length, 356.9 ft.; beam, 72.7 ft.; depth, 47.9 ft.; draft of water aft, 27.7 ft.; displacement, 11,818 tons. She has a water-line armored belt extending the whole length, and varying from 9.8 in. at the ends to 19.7 in. in thickness at the center; a protective deck 2.8 in. thick; and coffer dams protected by 3.9-in. plates. There are two large turrets of 14.6-in. plates, and four smaller ones with 3.9-in. plates. All the turrets can be worked by hand as well as by the electric motors which will be provided.



BATTLE-SHIP "JAURÉGUIBERRY," FOR THE FRENCH NAVY.

The armament includes two 30-cm. (11.8 in.) and two 27-cm. (10.63-in.) guns in the large turrets; eight 14-cm. (5.5-in.) guns in the four small turrets; four 65-mm. (2.56-in.), twelve 47-mm. (1.85-in), and eight 37-mm. (1.46-in.) rapid-fire guns; and six torpedo tubes.

The twin screws are driven by two triple-expansion engines, which are expected to work up to 13,500 H.P., and to give the ship a speed of 17 knots. Steam will be supplied by 24 tubulous boilers of the D'Allest type. This is the largest ship which is supplied entirely with these boilers.

Manufactures.

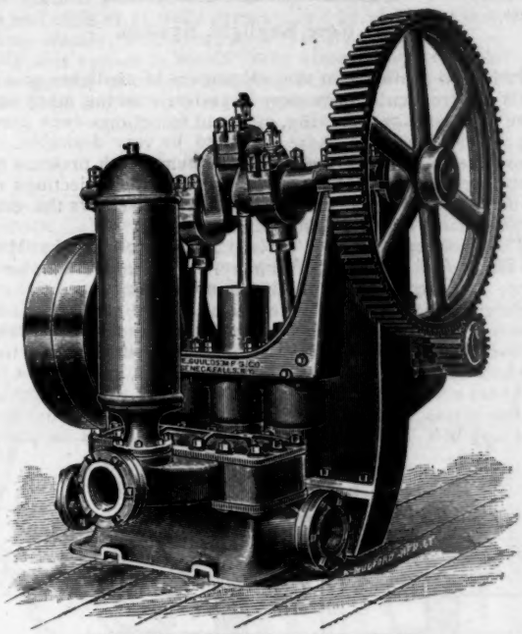
Power Pumps.

THE power pump may be defined as one in which the motive power is not a component part, but is transmitted to the pump by belt, gears or direct shaft connection from source of power, such as steam-engine, water-wheel, or electric motor, etc.

To obtain the highest efficiency in power pumps, both in power consumed and general working, it is of primary importance that the discharge be isochronous, or the pump to discharge equal volumes of water in equal times. The reason for this is that when once a column of water is given a certain velocity of discharge it is evident that any deviation from this constant velocity will result in loss of power in overcoming friction and inertia of the moving column. To illustrate: It is proposed to pump against a column of water 6 in. in diameter, 500 ft. vertically. If pumping mechanism is employed in

which this column is stopped and started at every revolution of the pump, it is evident that a large amount of power is consumed in overcoming inertia of the moving water; whereas, if the column of water when once started be maintained at a certain uniform velocity, the power required to overcome inertia of moving water is reduced to a minimum.

Careful consideration will show that the required conditions will best be met by a triple-acting pump, with its cranks set at



GOULDS' TRIPLEX POWER PUMP.

equal intervals or 120° apart. The illustration given shows a pump of this description made by the Goulds Manufacturing Company at Seneca Falls, N. Y., and called by the manufacturers a triplex power pump. As shown in the cut, the cylinder body, containing three independent cylinders and journal-boxes for carrying main shaft, is bolted to a case. Base contains suction valves through which water is drawn from source of supply into pump-chamber, and then upon the descending of the plunger they discharge through valves into chamber connected with the air vessel to discharge pipe. The plungers are of the hollow trunk pattern, fitting exactly the cylinders through which they work. At the upper end of cylinders is the long packing box which contains hemp or fibrous packings, preventing leaking of water around plungers. This is held in position by a gland tightened down at will by a gland-bolt. Crank-shaft is operated by large spur gear engaged by a small pinion which in turn receives its power from the pulleys. The style of valves employed varies with the work which the pump is required to do. For cold water, a rubber valve with leather face is employed; for hot water, the regular standard metal valve, with beveled seat; for pumping thick stock, tar, etc., the ball-valve pattern.

These pumps are made in a number of different sizes, varying from 1¼ in. diameter of cylinders and 2 in. stroke up to 9 in. diameter and 10 in. stroke; they are adapted to a very wide range of work, including boiler feeding, filling tanks, creating hydraulic pressure, etc., etc. The pump shown is arranged to run with a belt, but can be used also with an electric motor or other application of power.

A New Triple-Drum Sander.

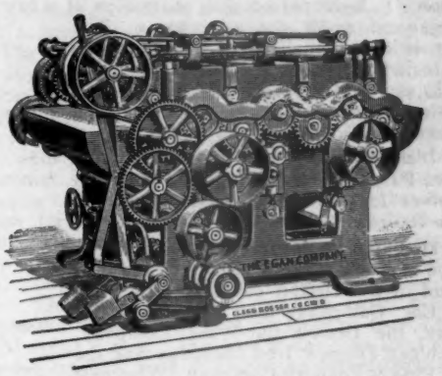
THE illustration herewith shows the latest machine of this class, which presents some important improvements. It is made at present in three sizes, 36-in., 42-in. and 48-in., to which 54-in. and 60-in. machines will soon be added. The present tendency is to use wide machines, owing to the change of system in making up furniture, interior, and car work, etc. The wide machines enable the operator to place his stock and feed the same diagonally through the sander. This is indispensable when sanding the cross-rails on stock that is framed up.

The frame is of neat design, made heavy in proportion to the width of the machine. All of the necessary parts are planed perfectly true, and when bolted together make a very solid and rigid frame, capable of standing up to the very hardest kind of work that the machine may be put to, and absorbs any vibrations which may arise in the machine from time to time.

The feed is very powerful, consisting of eight feed rolls of large diameter all heavily geared and made of solid steel and so placed in the machine as to allow very short stock to be sanded. The upper feed rolls are driven by an improved system of expansion gearing, feeding through the machine stock of any thickness from ¼ in. to 6 in. The upper feed rolls and frame are made to raise and lower by power and driven from the countershaft contained in the machine, so that it does not require a separate device to obtain this movement, and it is certainly a very desirable one, taking into consideration that every time a change of paper is made the upper feed rolls and frame must be raised and lowered to put the paper on the middle drum.

The three upper pressure rolls, one for each drum, are made to raise and lower parallel, independent of each other and operated by shafts, gears and hand-wheels, and can be adjusted to suit the different kinds of stock to be finished.

The drums are made of solid metal, having a single fastening device for holding the paper and also for tightening same at any time the operator finds it necessary to do so. Each drum is thoroughly balanced and made with large steel shafts with extra long bearings lined with genuine babbitt. Each drum is made to raise and lower independent of the other and from the working end of the machine, and this is accomplished without stopping the machine. This is a very desirable feature, and not



NEW TRIPLE-DRUM SAND-PAPERING MACHINE.

found on some of the machines of this kind. The last drum is fitted up with a patent brush attachment which is indispensable for fine work. It brushes the dust from the board before it goes through the feeding out rolls. Each drum is made to oscillate at a high rate of speed.

This is a very useful machine for many purposes, including interior finish, car work and similar work. It is made by the Egan Company, Nos. 194–214 West Front Street, Cincinnati.

General Notes.

THE new circular lately issued by Mr. Robert A. Keasbey, New York, gives certain reductions in the price-list of his magnesia sectional coverings. The circular contains some interesting statements with regard to these coverings and an account of the method of applying them, illustrated by diagrams. It may be noted here that the demand is rapidly increasing, and a very satisfactory business is reported by the manufacturer.

THE Ashton Valve Company announces that it has bought the entire plant, material and business of the Boston Steam Gage Company, together with a series of valuable patents, and has consolidated the business with its own. The company has secured the services of the former manager of the business, Mr. H. L. Willard, long and favorably known to the trade. The Ashton Company will manufacture all classes of steam pressure and vacuum gauges, hydraulic gauges, water pressure and ammonia gauges, and all similar instruments used in connection with steam plants, being more particularly the sole manufacturers of the "Boston Patent" steam gauge.

THE Pennsylvania Steel Company has recently added a number of new tools to its machine shops at Steelton, Pa., in order to provide needed facilities for the rapidly increasing amount of work called for.

THE Board of Public Improvements of St. Louis will receive at its office in that city until August 9 proposals for furnishing all the materials, constructing and erecting at the water works at Bissell's Point one high-service pumping engine, five boilers and all the appurtenances. Full particulars can be had at the office of the Board.

THE St. Charles Car Company, St. Charles, Mo., is building 10 passenger cars for the Vandalia Line.

THE New York Car-Wheel Works, Buffalo, N. Y., are very fully equipped with special machinery for making and finishing wheels. In addition to the ordinary work on wheels, at this establishment they are centered, turned true on the tread and balanced. A special department lately added is for wheels and axles for electric motors. The New York office of the Company is now at Bank and West streets.

THE Builders' Iron Foundry, Providence, R. I., is now finishing and assembling 43 new 12-in. breech-loading mortars for coast defense. This will make, with the previous contract, 73 of these mortars built for the United States Government.

THE Pullman shops of Pullman's Palace Car Company are building 55 passenger cars for the Chicago, Burlington & Quincy Railroad.

THE Chattanooga Car & Foundry Company, Chattanooga, Tenn., is making arrangements to build passenger cars as well as freight cars at its works.

THE works of the Barney & Smith Manufacturing Company in Dayton, O., have passed into possession of a new corporation organized under the same name. The property is now capitalized at $4,500,000, the issues including $1,000,000 in 6 per cent. bonds, $2,500,000 in preferred stock and $1,000,000 in common stock. There is no change in management.

THE Dickson Manufacturing Company in Scranton, Pa., has completed 10 consolidation locomotives for the New York, Ontario & Western Railroad.

THE Michigan-Peninsular Car Company is the name of a new concern formed by the consolidation of five Detroit companies—the Michigan Car Company, the Peninsular Car Company, the Detroit Car-Wheel Company, the Michigan Forge & Iron Company and the Detroit Pipe & Foundry Company. The new corporation issues $5,000,000 in 8 per cent. preferred stock, $5,000,000 in common stock and $2,000,000 in 5 per cent. bonds, making a total capitalization of $10,000,000. The combined works have a capacity of nearly 100 freight cars a day.

IT is stated that arrangements have been completed toremove the works of the Ingersoll-Sergeant Rock Drill Company to Easton, Pa., where large shops will be erected.

THE Cleveland Electrical Manufacturing Company, manufacturer of the American watchman's time detector, has contracted to furnish the Chicago Telephone Company with all the time detectors they will use for the next five years, and has just shipped 100 instruments on this contract. These time detectors all have capacity for 10 stations and are fitted with a movement which revolves once in seven days, so that the dial on which the record is received can be used for a week without changing.

THE new catalogue of the Consolidated Car Heating Company, Albany, N. Y., calls attention to several recent improvements in car-heating apparatus. These include:

1. A new hot-water circulating low-pressure system known as the multiple circular drum system, which will work with 4 lbs. pressure. Its application does not break the seal of any water heater, and it can also be used without any water heater.

2. The improved commingler system, noiselessly injecting steam and leaving the water heater always ready for building a fire, if needed. This system will work with 2 lbs. pressure.

3. The dust guard for the Sewall steam coupler. The coupler is always to hang in this guard when not in use, and it takes the place of the chain and protects face of coupler from injury.

4. The special hose nipple for Sewall steam coupler. This special nipple is so designed that it absolutely fixes the position of hose when forced on such nipple, and insures standard length when couplers are repaired by putting on new hose; it is of special value in putting on new hose.

THE Delaware & Hudson Canal Company is fitting a number of its passenger cars with the Gould automatic coupler.

THE Washburn & Moen Manufacturing Company, of Worcester, Mass., has nearly completed extensive branch works at Waukegan, Ill., whence Western orders will be filled. The new plant will have a capacity of 400 tons a day, and is fitted with all the latest improvements.

A New Skylight System.

IT is well known that the adjustment of skylights and glass roofs has frequently been very imperfect, causing much annoyance from leakage, breaking, etc., and sometimes even preventing the use of glass where it would be very desirable. The accompanying illustrations show a system which presents many advantages, and which seems to obviate the objections made to those generally in use. The larger cut shows the general arrangement, figs. 1–5 giving the details.

This system has been devised and introduced by Messrs. A. Edgcumbe Rendle & Company, of Philadelphia, who have given it the name of the "Paradigm" system.

Referring to the cuts, the astragal or channel bar *A* is made of strong steel, varying in width from 1 in. to 2 in., depending on the distance between the roof purlins to which said astragals are bolted, by means of malleable iron shoes, as shown at fig. 1.

About every 18 in. apart, ¼-in. holes are made in the sides of the astragal bar, into which are secured the cross-bolt *B* and eye-bolt *C*. These bolts secure the glass in place by means of the cap *D* and the brass nut *E*. This cap is made of a bent piece of sheet copper, fig. 1, or narrow pieces of iron covered with copper or lead, figs. 2 and 3.

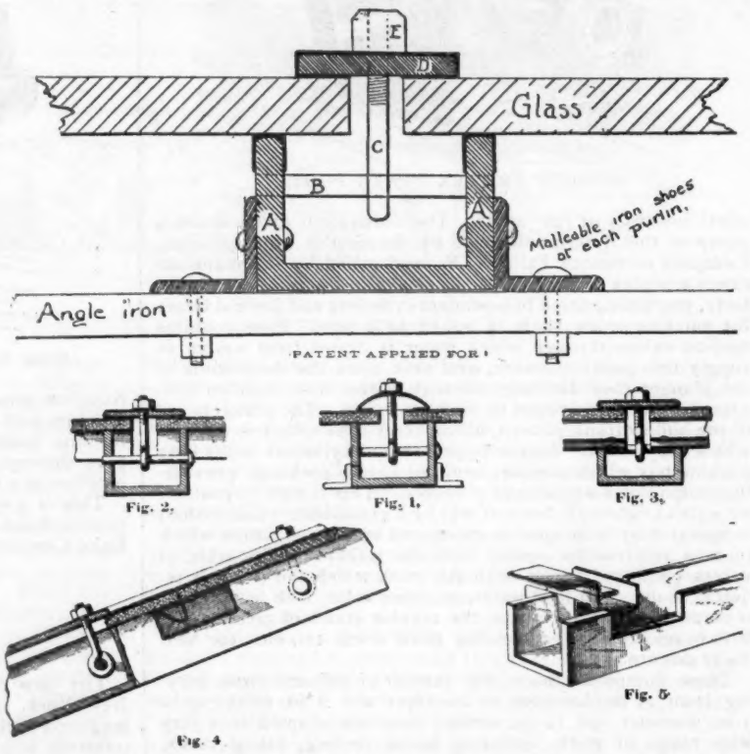


Fig. 2. Fig. 1. Fig. 3.

Fig. 4 Fig. 5

THE RENDLE GLASS ROOF SYSTEM.

The new cross or joint-bar of the Paradigm system is made of copper or any sheet metal of the shape shown at figs. 4 and 5. The upper sheet of glass lays on the ledge of cross-bar as shown, and can be set in putty or dry; the sheet of glass immediately below it rests on the edge of cross-bar, and is covered by the cross "cap," which is preferably made of lead or copper.

At the top of the lower sheet of glass, fig. 4, there is a small gutter. In this gutter, every 2 in. apart, ¼-in. holes are punched in the metal before bending. These holes permit any water that may be driven in under the cross cap to drop into the cross-bar, and thus find its way into the main astragal.

Condensation forming on the under side of the glass runs down the glass, and drops into the cross-bar, and so into the main channel bar.

The cross-gutter bars are fitted into slots cut in the steel channel bars, 1½ in. long by ¼ in. deep, as shown at fig. 4, and particularly at fig. 5; and they are made the exact length of width of glass, and lap over main astragal or channel bar, as shown at fig. 5, so that all rain water or condensation finds its way into the main channel bar.

For vertical glazing, the Paradigm system is unsurpassed. Sides and ends of railroad depots could be glazed in this manner very readily, with advantages that are apparent.

With this system it would seem almost impossible for the roof to get out of order; and in case of breakage of glass the broken plate can be very easily replaced.

A New Lubricator.

THE illustrations here given show the lubricator made by the Automatic Lubricator Company, New York, for use in car and locomotive axle-boxes. Fig. 1 is a longitudinal section of a journal-box and fig. 2 a cross-section, while fig. 3 shows one of the lubricating pads on a larger scale.

The lubricator, it will be seen, is a pad which is held up against the lower side of the journal by a spring, and is provided with a wick to draw up the oil. The pad is of such

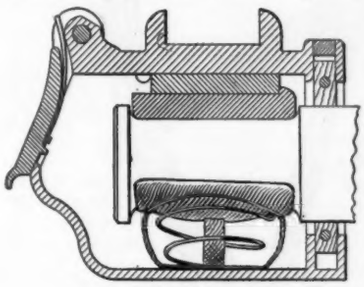


Fig. 1.

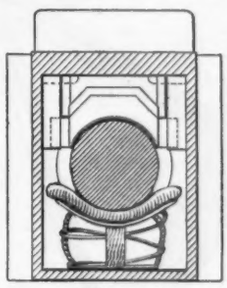
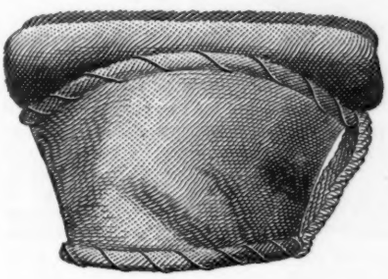


Fig. 2.



THE AUTOMATIC LUBRICATOR.

Fig. 3.

material that it will remain saturated as long as there is any oil in the box, while the surface will not glaze or harden by friction. It can be very easily and quickly put in place, and will remain constantly in the proper position after it is placed in the box.

On the Staten Island Rapid Transit Line, where a number of these lubricators have been in use, the cost of keeping boxes in order is reported at 1½ cents per month, against 7⅛ cents with boxes packed with waste and oil, and tests on other roads have shown a great saving. The average life of a pad has been shown to be about 18 months on cars in constant use. It may be mentioned that the New York, New Haven & Hartford Company has applied these pads on all its locomotive and tender journal-boxes, having nearly 8,000 of them in use.

Baltimore Notes.

THE engineers in charge of the Baltimore Belt Railroad tunnel report the amount of tunnel completed in the different shafts to July 15, as follows: Preston Street, 1,088 ft.; Madison Street, 1,144 ft.; Franklin Street, 765 ft.; Saratoga Street, 953 ft.; German Street, 1,271 ft.; Howard Street covered way, 58 ft.; making a total of 5,279 ft., or practically a mile. This makes a continuous stretch of tunnel from the north head of the Franklin Street shaft to the south side of Lombard Street, a distance of 3,047 ft. There yet remains to be completed 792 ft. The work is being pushed with all possible despatch.

THE Baltimore Electric Refining Company has contracted to enlarge its plant at Canton, so that its tankage or capacity will be doubled. The additions and changes will be completed in the early fall, when the company expects to be able to treat 4,000,000 lbs. of copper ore or matte per month. The company now employs 150 men, which number will be largely increased. Just one year ago the company was organized for refining and separating metals by electrolysis. The officers are Samuel Keyser, President, of New York; R. Brent Keyser, Vice-President and Treasurer, and Joseph Clendenin, Jr., Secretary. The plant was located on Fourth Avenue, Canton, in proximity to the Works of the Baltimore Copper Smelting Company. The interests of the two companies are closely allied and they are also connected with the great Anaconda copper mine in Montana. The doubling of the capacity of the Baltimore Electric Refining Company is due to the decision of President J. B. Haggin, of the Anaconda mine, to have the entire output of the mine refined in America instead of in Europe, and it has been arranged to have the product of the mine undergo the electrolytic treatment at Baltimore. The silver and gold obtained from the Anaconda ore constitutes an important element in the value of its output, and hereafter it is proposed to extract the precious metals before marketing the copper. The output from the Anaconda mines is for the present to be reduced, but it is said that the treatment of all the material in America instead of sending a large part of it abroad in the form of argentiferous matte or ore will add largely to the employment of labor at the smelting and refining works, and thus compensate for the reduced force at the mines.

THE contract for cabling the Blue Line of the City Passenger Railway Company has been awarded to Edmund Saxton, who has built a number of cable roads in Washington and other cities. The Blue Line will be built in substantially the same manner as the Red and White Lines of the same Company are now being constructed. The yokes and rails are being distributed on St. Paul Street, beyond North Avenue. Mr. Saxton says the work on Charles Street will be finished during the summer, while many of the residents along that street are on their summer trips. Mr. John Waters, Superintendent of Construction of the Charles Street power-house, has begun the excavation for the building. It is expected to have the Blue Line cable in operation before the end of the present year. The Gay Street tracks for the Red Line cable are being constructed. The East Baltimore part of the White Line is nearly finished. The Red Line tracks are laid easterly to Eutaw Street, and the White Line tracks are finished from Druid Hill Park to Fayette Street. The part of the road next to rebuild is along the crowded part of Baltimore Street from Eutaw to Exeter Street. As much of this work as possible will be done during the night.

THE Belt Railroad officials some time ago accepted a proposition of the Thompson-Houston Company to give a trial to an electric motor, which that company claimed could generate sufficient power to haul trains through the tunnel without the use of steam. In addition to supplying motive power for the trains, the plant to be built will have capacity and appliance to furnish electric light for all the Baltimore & Ohio buildings in the city, including those at Locust Point. This change in the plan will necessitate a change in the location of the electric plant. The original intention was to build in the neighborhood of the Bolton lot. This has been abandoned, and the company are looking for a location in the neighborhood of Camden Station or the new Belt depot. Mr. W. H. Knight, of the Thompson-Houston Electric Company, is in Baltimore looking for a suitable location for the power-house which the electric company will build to operate trains in the Belt tunnels; also as to proper water supply. For the boilers artesian wells will be sunk, and will give sufficient supply. These wells are impracticable, however, for the supply needed for condensing purposes, which requires a large volume. Mr. Knight thought he might secure his supply from the basin, but abandoned this idea when he saw the foul condition of the water in the summer. It has been suggested that a sufficient supply can be obtained from near the mouth of Gwynn's Falls, and this suggestion will probably be adopted. The motor the electric light company is building to haul the heavy trains through the tunnel will be 80 tons in weight.

THE Baltimore & Ohio Company has just closed a contract with the South Baltimore Car Works, Curtis Bay, Baltimore, to thoroughly repair 100 of their Wickes refrigerator cars.

THE South Baltimore Car Company is arranging plans for building shops for the construction and repairs of passenger cars. The shops will be of the latest design, and equipped with improved machinery. The shops will be located at Curtis Bay near their present freight-car shops.

THE Edge Moor Iron Works, Wilmington, Del., have taken a contract to build 11 new iron bridges for the New York, Susquehanna & Western Railroad.

THE Lake Roland Elevated Railroad has let the contracts for the construction of the greater part of the line. The contract for laying the track was awarded to the Duplex Railroad Company of New York. This is a new form of construction, and is all of metal, even to the ties. The duplex rails have no joints, and the whole framework of rails, plates and ties are bolted together, making a very rigid and stable track. The weight of double rails is about 72 lbs. to the yard. All but the elevated portion of the road is to be completed within 90 days. The elevated portion is expected to be finished by October 1. The contract for the electric equipment was let to the Thomson-Houston Company, for motors, dynamos, and generators. The overhead equipment will be supplied by John G. White & Company, of New York. The contract for the motors is for the largest size ever built for street railroad service. Each car will carry two 30 H.P. motors. The cars will be capable of carrying two trailers, and they will move so steadily a change in grade will hardly be perceptible, and they will move at the rate of 20 miles per hour. The passenger cars will vary from 18 to 34 ft. in length, and their seating capacity will vary from 25 to 50. The contract for engines and boilers was awarded to the Corliss Engine Company, of Providence, R. I. They will be of the compound condensing tandem type, with 1,400 H.P., and, as the site of the power house will be at the point where Stony Run empties into Jones's Falls, the Company will have sufficient water. At this place the Company has about one acre of ground. For the overhead construction a metallic circuit will be used, and an unusually large copper wire will be used to feed the motors. This will have the effect of giving an even voltage. The Roland Park Company will erect upon the highest point within its grounds a water tower 70 ft. high, 20 ft. in diameter, and encircled by a spiral staircase of 105 steps 3 ft. wide. The whole structure will be of steel, and have capacity for 165,000 gallons. The contract to build it has been let to Riter & Conley, of Pittsburgh, for $8,000. The spiral stair-case will be lighted to the top by electric lights, and at the summit of the tower will be a balcony covered with a pagoda top and surmounted with a weather-vane. The water will be pumped into the tower by the large springs in the park, one of which has a daily flow of 25,000 gallons. The pump will be operated by electricity from the railroad. The building to be erected for the power station will be 60 × 125 ft., with provisions for extending it to a length of 180 ft. It will be of brick, with an iron roof, and two stories in height. The boilers, engines and generators will occupy separate portions of the main building. The floor of the engine-room will be 7 ft. above that of the boiler-room, so as to allow all of the steam pipes to run under the flooring and out of the way. The elevated portion of the road will be wholly of steel. The girders and braces will not obstruct the light, and yet be sufficiently close to make the structure as strong as it can be made. Stations will be built at Franklin Street, convenient to travelers on the Northern Central by way of Calvert Station, and at other points along the structure.

A New Rope Pulley.

THE accompanying illustrations show a sheave or pulley for wire ropes and cables devised by Mr. William F. Buswell. These pulleys have been furnished to some of the principal cable railroad lines in San Francisco, and have the feature of a hard wearing surface, without much departing from the common section and proportions for such sheaves. The following from Mr. Buswell's patent specification will explain the nature and objects of the system :

"My invention relates to pulleys or sheaves, especially such as are employed for wire rope under heavy strain, as in the case of traction cables for street railroads or in transmitting power by means of wire ropes or cables, and consists in constructing such pulleys or sheaves with a series of inserted segments, forming the bottom or wearing part of the groove or grooves in which the cables bear ; the segments being of chilled iron, steel, or other hard material, and so inserted and held as to be removed or replaced in whole or in part without disturbing the pulley or sheaves, and while the rope is in place.

"The object of my invention is twofold—mainly, to avoid wear of the main parts of the sheaves or pulleys by inserting the portions embraced by the cable and subject to abrasion and wear, also to some extent to obviate wear of the cables or ropes which occurs when they bear on soft iron that retains sand or grit."

BUSWELL'S PATENT ROPE SHEAVES.

The patentee states that with carefully made patterns the hard segments, made of chilled cast iron, steel, gray iron, or other hard material, can be inserted in a very complete manner, and the rim, when filled and closed by the side-plates, is, of course, safe from any accident or derangement such as may happen to built-up wheels or sheaves. The hard sections can be removed or replaced while the wheel is in position, and without removing the ropes, by taking off the side plates which are a little longer than the inserted sections.

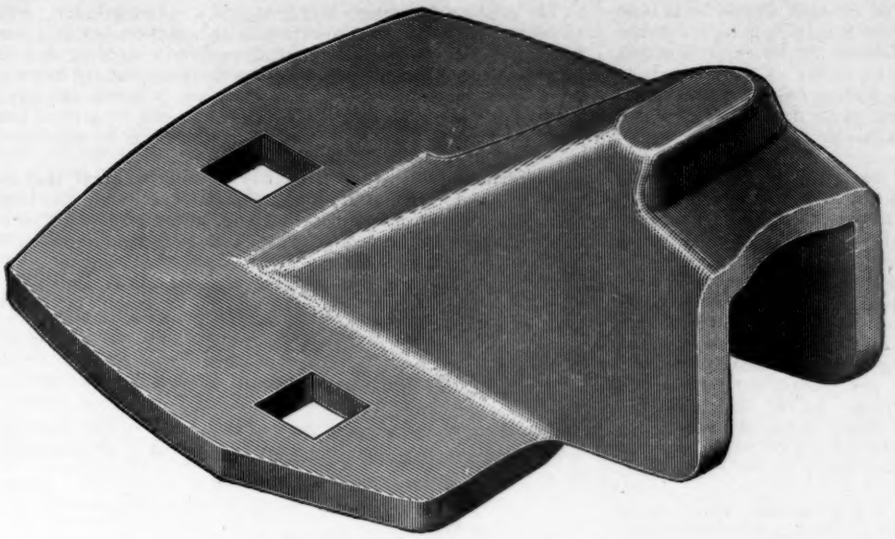
In the details shown, fig. 1 is a section of the rims for a single rope. Figs. 2 and 3 show sections of the inserted sections for a number of ropes or wraps, the construction of the sheaves being otherwise the same as for a single rope.

One would scarce expect that in the development of cable or rope gearing any difficulty would arise in so simple a thing as sheaves or pulleys, but their wear when exposed to grit and dust has called for a good deal of search and experiment to keep down the expense of maintenance, and such experiment has been in the direction of hard material. In the present case this end is attained because the chilled sections, being cast independently, can be as hard as metal can be made.

A Steel Rail-Brace.

THE accompanying illustration shows an excellent rail-brace formed by a die from steel plate. These braces are made of homogeneous steel, $\frac{1}{4}$ in. or $\frac{5}{16}$ in. thick, as may be preferred, and are so shaped as to have parallel vertical sides. These vertical sides are bridged across under the head of the rail to strengthen them at the point where the brace engages the under and outer side of the rail-head. The shape adopted gives a very strong and rigid brace with a moderate thickness of material. Being of a box form, it fits over the spike in the tie, and it is secured by three spikes. The spike holes in the foot-plate of the brace are left open on one side or entirely surrounded by metal, as may be preferred ; the brace itself can, of course, be made to suit any height or size of rail.

The form adopted for this brace prevents the rail from canting entirely, as the head is supported underneath, as well as the flange and web ; the strain on the spike on the inside flange of the rail is thus entirely removed. The brace being of steel will last an indefinite time, and cannot be broken in spiking



THE WEIR PRESSED STEEL RAIL BRACE.

down, as cast-iron braces often are. At the same time the method of manufacture enables the makers to furnish them at a low price.

These braces are made by the Weir Frog Company, of Cincinnati. We are informed that nearly 2,000,000 of them are now in use on different railroads, showing that they are well appreciated. The roads using them includes such lines as the Boston & Maine; Baltimore & Ohio; Pennsylvania Company; Illinois Central; Louisville & Nashville; Chicago & Northwestern; Chicago, Rock Island & Pacific; Atchison, Topeka & Santa Fé; Union Pacific, and the Northern Pacific.

An Engineer's Tape Level.

THE accompanying illustration shows a little device invented by Mr. Ernest McCullough, a California engineer, the use of which will readily be seen with very little description. It is a

McCULLOUGH'S TAPE LEVEL.

small level intended to be attached to a surveyor's tape about 8 or 10 in. from the end. In measuring a distance of 15 ft. or less with the proper tension the bubble of the level should be in the middle, but for greater distances an allowance must be made for the sag of the tape. In practice this can be readily ascertained by trying the tape on the surface known to be level, and marking the position of the bubble on the tube for distances of 25, 50 and 100 ft. In measuring, when the bubbles come opposite these marks the ends of the tape are at the same height. The level should be on the forward end of the tape when dragging chain in going uphill, and on the rear end in going down. Some engineers prefer a level on each end. The cut shows the device full size, and its weight is only 1 oz. It is used by clamping it to the tape by means of the two strings underneath, and can be attached or detached instantly.

This device has been meeting with great favor wherever used, and is recommended as a very convenient addition to an engineer's outfit.

Pennell's Water-Purifying Plant.

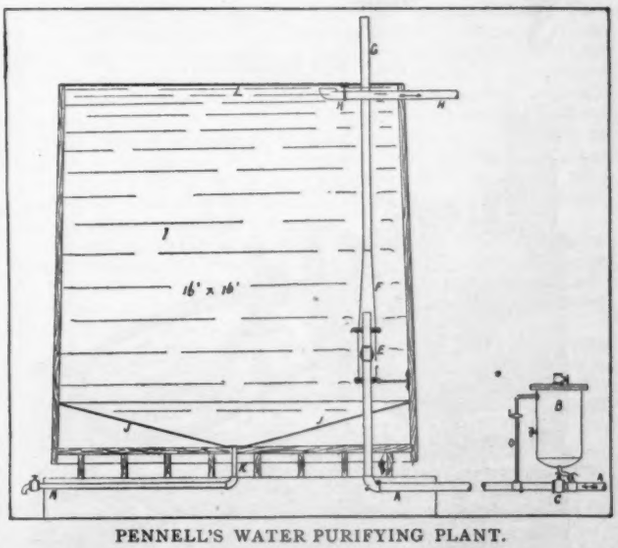
THE importance of purifying the water used in locomotive and other boilers has long been recognized. The most important impurities are the scale-forming salts which exist in various forms in what is generally known as hard water. Boiler scale most generally consists of the carbonates and sulphates of lime and magnesia, which are found in varied quantities in almost all of the water in the Middle and Western States, wherever calcareous rock is found, mixed with vegetable matter or mud that may be in suspension in the water.

When water containing these scale-forming salts is used in a boiler, the pure water evaporates, leaving the salts behind. If we know the amount of water evaporated in a given time and have a chemical analysis of the water, we can judge approximately of the amount of solid material which remains in the boiler, and which gradually settles down and forms hard scale, generally on the fire-box sheets, the tubes and other portions of the boiler which are most directly exposed to heat.

The ordinary mud or residuum found in dirty water can generally be disposed of by settling, but frequently an apparently bright, clear water is found to be hard, owing to the presence of carbonates of lime or magnesia in solution. The most direct and simple method of purifying such waters is by the addition of a sufficient amount of slacked lime to the water to combine with the carbonic acid. The carbonates will then precipitate, giving a clouded appearance to the water, and in a given time will settle.

The accompanying drawing shows an arrangement for purifying water, which has been devised by Mr. Arthur Pennell. The drawing shows a plan arranged to work in connection with an ordinary tank 16 ft. in diameter and 16 ft. depth. A closed iron tank *B* is placed in any convenient position alongside the feed-pipe and connected with it by an inlet-pipe entering at the bottom, and an outlet-pipe *D* returning from near the top of the tank. Between these two a gate-valve *C* is placed on the feed-pipe. By partially closing it any desired percentage of water can be compelled to pass through the chemical tank *B*, and there become charged with the lime or other ingredient which may be found necessary to cause the salts in the solution of the water to precipitate. The feed-pipe then enters the settling tank *I*, as shown in the drawing, passing upward through a tee *E*, to the upper end of which is bolted a funnel *F*. The neck *G* of this funnel extends up above the top of the tank so as to carry off any imprisoned air or other gas. The water passes out into the tank through the horizontal limb of this tee, which is so mounted that this horizontal axis is at right angles to the radius of the tank passing through the tee, the result being that the current of water from the feed-pipe imparts a rotary motion to the water in the tank.

Experience has shown that this tee is best mounted so that its horizontal axis is at about one-fourth the height of the tank, permitting the settling to be carried on at the bottom of the tank, while the clear water rises to the surface, whence it



PENNELL'S WATER PURIFYING PLANT.

is thrown off through the outlet-pipe *H*. The capacity of this tank should be sufficient to allow time for the chemical combination to act, and the precipitate form and deposit, and for this purpose account must be taken of the maximum demand for water. The rotary motion imparted to the water in the tank assists the mixing of the particles and hastens the action.

It is considered that the capacity of the tank should be at least three times as great as the maximum hourly demand for water, and if it could be increased to four or five times, it is better. A false bottom, *J J*, which may be either of light boards or sheet-iron, assists the sediment in finding its way to the center of the floor of the tank, where it will settle down over the opening of the waste-pipe *K*, whence it can be flushed away as often as required.

In using this plant it should be borne in mind that the amount of scale-forming salts in any water supply will vary with the season of the year and the weather, and the amount of ingredients used in the chemical tank should be varied so as to correspond as nearly as possible. This is especially the case where the water supply is taken from a river. For example, it has been found by actual test that in water taken from the Missouri River in the month of January, there were 13 grains of carbonates and 11 grains of sulphates of lime and magnesia per gallon; while during the June freshet there were only about three grains of each per gallon, but there was a large quantity of mud in suspension. In the first place, the chemical ingredients needed were about 1½ lbs. of slacked lime and 1 lb. of soda ash per thousand gallons of water, whereas in the latter case ½ lb. of caustic soda and ½ lb. of potash alum would do the work.

It is hardly necessary to state the advantages obtained by purifying the water from the bulk of the scale-forming salts. When this is done the water entering the boiler will contain a certain amount of residuum, but it will not be the salt matter which forms a hard scale, but simply loose slush, which can readily be blown off. It may be said also that there is a great advantage in ascertaining the composition of the water and in being able thus to treat it intelligently.

For railroad work this device can be attached to existing supply tanks. The arrangement of the outlet-pipe *H* near the top of the tank is considered important, and would in fact be desirable in any tank, as the water near the surface will always be clearer than that at the bottom.

This system has been tried on the Union Pacific with very satisfactory results, and is now being introduced on other roads by the inventor.

The Stow Flexible Shaft.

THE accompanying illustration shows, in fig. 1, a section of the flexible shaft invented by Mr. Nelson Stow and made by the Stow Manufacturing Company, and in fig. 2 one of the numerous applications which can be made of this shaft. The

FIG. 1.—STOW FLEXIBLE SHAFT.

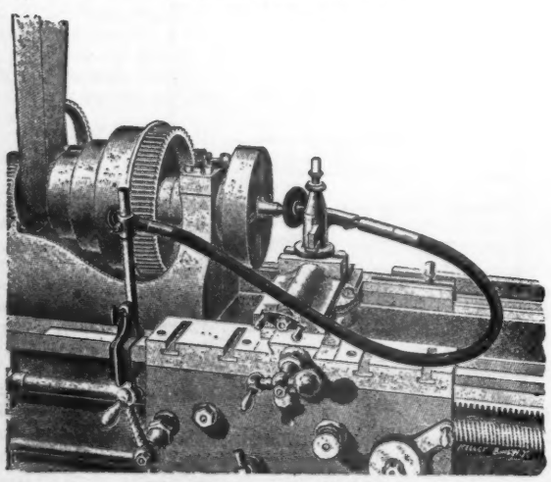


FIG 2.—STOW CENTER GRINDER.

success of this device within a few years is another illustration of the fact that a really useful tool is sure to make its way. It has taken position as a standard tool, and is in use in a very large number of shops all over the country.

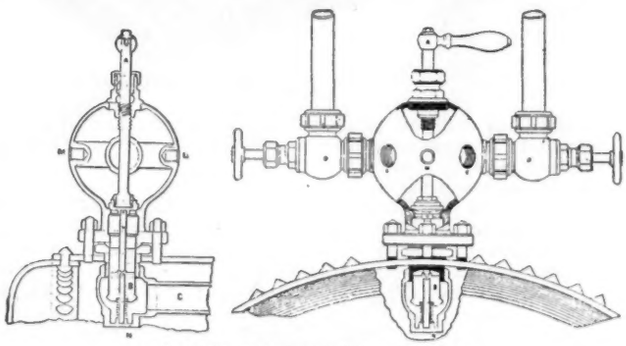
The application shown in fig. 2 is of a center grinder. This consists of a 3½-ft. flexible shaft with the traction pulley at one end, the other attached to a sliding spindle holding a 3-in. emery-wheel. The spindle turns in the tool-post the same as an ordinary tool, and it can be set in place or taken down in a very short time, and with it a lathe center can be ground true very quickly. Numerous other applications can be suggested, which are probably well known to our readers.

The demand for these tools has become so great that the Company has recently taken up its quarters in one of the best-appointed shops to be found anywhere, where many appliances of similar description to that shown above are manufactured as well as the shaft.

The officers of the Company are Nelson Stow, President; C. E. Warner, General Manager, and C. F. Hotchkiss, Treasurer, and their office is at Binghamton, N. Y.

The Detroit Supplemental Steam Dome.

THE accompanying cuts show a very neat device made by the Detroit Lubricator Company, and called a supplemental



HODGE'S SUPPLEMENTARY DOME.

dome. It is intended to prevent the necessity of the numerous holes in the boiler which are usually made for steam connections about the cab.

The dome is located on center of boiler head, and all steam connections are made to it. It is provided with a cut-off valve *A*, having a lever handle, one-half turn of which closes the connection between it and the boiler, enabling the engineer to repair or repack any of the connections without loss of time in allowing engine to cool. The dome is also provided with a security-valve *B*, located inside the boiler, which closes instantly, in case the dome should become detached by accident, and thus prevent escape of steam, and great risk of scalding the engineer and fireman. From five to seven dry pipes are dispensed with by using this dome; and taking steam from a common reservoir, nothing but dry steam can ever be furnished to the different connections.

The ordinary size dome is 9¾ in. in diameter, and is complete with valves *A* and *B*, as in cut, and is tapped to fit standard connections.

Manufacturing Notes.

AT the Wheeler Yard, West Bay City, Mich., the large steamer *Gilbert* and the light-ship No. 51 have recently been sent away ready for service. The *W. H. Gilbert* is one of the largest vessels ever built in the yard. She is 345 ft. long over all; 328 ft. keel; 42 ft. 6 in. beam, and 24 ft. deep. She has a triple-expansion engine with cylinders 23 in., 37 in. and 62 in. in diameter by 44 in. stroke. Steam is supplied by three boilers, each 12 ft. 8 in. in diameter and 12 ft. 6 in. long. The engines have been built by the Frontier Iron Works, of Detroit.

Wheeler & Company have just closed a contract for another freight boat similar to the *Gilbert*. The general dimensions will be the same, but there will be a slight difference in the motive power. The triple-expansion engine will have cylinders 20 in., 32 in. and 54 in. in diameter and 42 in. stroke. The propeller will be 12 ft. in diameter and 14 ft. 9 in. pitch. There will be two boilers 12 ft. in diameter and 12 ft. long, built for 160 lbs. pressure. The engines for this boat will be built in the Wheeler Works, the machine shops having recently been enlarged so that ships built there can be engined in their own shops.

IT is reported that the Johnson Switch & Signal Company has been consolidated with the Hall Signal Company of New

York. The Johnson Company was organized by Charles R. Johnson some years ago, and controls some valuable patents for interlocking and other signals. It is at present equipping the New York Central line to Mott Haven, and has some other large contracts.

THE St. Charles Car Company, St. Charles, Mo., during the past six months has made large additions to its freight-car plant, and has put in a new stationary engine and a number of tools, increasing the output 8 cars per day. The shops have just completed 1,500 cars for the Atchison, Topeka & Santa Fé, and are now building 1,000 box and 500 coal cars for the Missouri Pacific. The passenger-car plant is also being enlarged to meet the demands made upon it. They are now building an addition which will hold 12 passenger cars. The latest orders received include 10 coaches for the Vandalia Line and 20 for the Northern Pacific. The latest freight order is for 300 cars for the Missouri, Kansas & Eastern road.

Some time ago the Company established a branch shop at Denver, Col., under the charge of the Assistant General Manager, Clarence H. Howard. This shop was established to repair, rebuild, and put in good order a large number of narrow-gauge cars belonging to the Denver & Rio Grande Railroad. This work has been substantially completed, and the branch shop will soon be closed.

PERSONALS.

J. W. SCHAUB has resigned his position as Engineer of the Detroit Bridge & Iron Works.

ROBERT ENGLISH has been appointed General Master Mechanic of the Atlantic & Pacific Railroad.

ALFRED P. BOLLER, the well-known bridge engineer, has been dangerously ill of typhoid fever, but is now recovering.

E. J. PEARSON has been appointed Principal Assistant Engineer of the Wisconsin Central Railroad, with office in Chicago.

A. W. GIBBS, recently with the Central Railroad of Georgia, is now Master Mechanic of the Atlanta Division of the Richmond & Danville Railroad.

THE office of R. D. WADE, Superintendent of Motive Power of the Richmond & Danville Railroad, has been transferred from Atlanta, Ga., to Washington.

D. J. DANELL, for some time past with the Illinois Central Railroad, has been appointed Mechanical Engineer of the South Chicago Works of the Illinois Steel Company.

PROFESSOR J. B. JOHNSON has retired from the firm of Johnson & Flad, Consulting Engineers, on account of the pressure of his duties in Washington University and elsewhere.

J. J. ELLIS has been appointed Master Mechanic of the Chicago, St. Paul, Minneapolis & Omaha Railroad, succeeding MATTHEW ELLIS, who has resigned on account of ill health.

GENERAL V. E. MCBEE, recently with the Central Railroad of Georgia, has been appointed General Superintendent of the South Carolina lines of the Richmond & Danville Railroad.

GEORGE A. HANCOCK, formerly with the Atlantic & Pacific Railroad, is now Superintendent of Motive Power of the San Antonio & Aransas Pass Railroad, with office at San Antonio, Texas.

CHARLES F. STOWELL, for some years past Bridge Engineer of the New York Railroad Commission, has resigned that position and has, with M. C. CLAY and A. C. CUNNINGHAM, formed the American Engineering & Inspection Association, which will have its headquarters in Albany, N. Y.

CLARENCE H. HOWARD, recently Assistant General Manager of the St. Charles Car Company, has been appointed Secretary of the Safety Car Heating & Lighting Company, and will remove his residence to New York. Mr. Howard has done a great deal of hard and successful work while with the St. Charles Company.

OBITUARIES.

COLONEL CHARLES E. BLUNT, U. S. Engineers, died suddenly in Boston, July 10, aged 69 years. He was a native of New Hampshire, and graduated from West Point in the Class of 1846. During his 40 years' service in the Engineer Corps, he had a wide experience in charge of fortifications and river and harbor work on the Atlantic Coast and the great lakes. He was stationed for 15 years at Buffalo, N. Y., and was retired at his own request, in January, 1887.

W. K. MUIR, who died June 28, was for a number of years connected with the former Great Western Railway as Assistant General Superintendent. He was also for some time General Manager of the Detroit, Grand Haven & Milwaukee Railroad, and was afterward General Superintendent of the Michigan Central. He was born in Scotland in 1829, and after some service on Scotch and English railroads came to Canada in 1852 and was employed on the first section of the Great Western. Mr. Muir retired from the Michigan Central several years ago and has been since President of the Eureka Steel Works.

PROCEEDINGS OF SOCIETIES.

Roadmasters' Association of America.—Mr. J. H. K. Burgwin, Secretary, announces that the Annual Convention will be opened at Chattanooga, Tenn., on Tuesday, October 18 next. One meeting will be held in Chattanooga, and then the Association will adjourn to meeting for the business sessions at Atlanta, Ga., on the following morning.

American Institute of Mining Engineers.—The sixty-second meeting was held at the Hotel Champlain, near Plattsburgh, N. Y., beginning July 5. At the opening meeting Mr. F. S. Witherbee made an address on the Early Development of Iron Manufacture in the Champlain Region, where a large number of forges were in operation at a very early date. The President, Mr. John Birkinbine, then made an address on the Influence of Location on the Pig-Iron Industry, showing the various changes which have occurred from the first establishment of the industry in this country, and the causes which produced them, the chief among which were the proximity to market and supply of ore and fuel.

Memoirs of the late Dr. Hunt and of William P. Shinn were read. Dr. James Hall, State Geologist, exhibited the new geological map of New York.

On the second morning the members proceeded to Port Henry and thence to Crown Point and Mineville, inspecting the furnaces and mines at those places. In the evening a session was held at which several papers were read, including one by Dr. C. B. Dudley on Specifications for Iron and Steel.

On Thursday morning an excursion was made to the Chataugay Iron Mines and Lake Saranac, a stop being also made at Lyon Mountain.

The meeting was concluded by two business sessions, at which a number of papers were presented and some of them were discussed.

Mechanical Engineering Teachers' Association.—This Association was formed at a meeting held in Columbus, O., in June, 1891, the object being to secure by co-operation the best courses of study and the adoption of methods of instruction which may lead to the highest efficiency of mechanical engineering schools. A number of members have joined and others are expected to be present at the next meeting, which will be held in Rochester, N. Y., August 18. The place and time has been chosen in order to accommodate those members who wish to be present at the meeting of the American Association for the Advancement of Science.

The officers of the Association are: President, S. W. Robinson, Columbus, O.; First Vice-President, C. W. Scribner, Ames, Ia.; Second Vice-President, O. P. Hood, Manhattan, Kan.; Secretary, A. J. Wiechardt, South Bethlehem, Pa.; Treasurer, Storm Bull, Madison, Wis.

In the circular announcing the meeting the following points are suggested for study either for the presentation of papers or for general discussion:

"What subjects should be embraced in the course of Mechanical Engineering leading to graduation?

"Should any of them be optional?

"Should there be a post-graduate course, and if so in what should it consist?

"What should be the degrees for the above, and what the studies?

"Should there be included one or two modern foreign languages?

"What engineering studies should be included?

"What amount of mechanical laboratory should there be included?

"What subjects should be included in the mechanical labora-

tory; how much practice with the object of mechanical and manual training?

"How much fine mechanical practice, such as scraping of surface plates, grinding of standards, etc.?

"Should the construction of articles of manufacture be attempted at the school laboratory?

"What testing should be attempted?

"Should any part of the laboratory practice be classified as shop work, and so named unless articles are made for sale?

"Should anything be introduced that should be called 'shop work'?

"Should that portion of the laboratory embracing the manual element be classified as 'shop,' 'school shop,' 'work shop,' etc., or elementary mechanical laboratory?

"Should the more advanced portion, embracing testing of various kinds, be classified in such way as advanced mechanical laboratory, testing laboratory, etc.?

"It is further suggested that particular attention be given to the number of hours devoted to a subject, and the ground covered; the method of instruction—*i.e.*, whether by lecture, recitation or practice, separately or combined."

American Boiler Manufacturers' Association.—The Fifth Annual Convention was held in Buffalo, N. Y., beginning June 14, and was more largely attended than any previous convention. A number of important matters came up for consideration.

The Committee on Uniform Inspection Laws reported progress toward the adoption of a common standard for inspection in the different States, and also progress toward the adoption of a national law.

The Committee on Riveting and Calking reported progress, and was instructed to proceed with the tests which have been undertaken. These tests will include the bursting of boiler shells prepared in the same way as for actual service.

The Committee on Materials was continued, a carefully prepared report having been accidentally destroyed by the burning of the Chairman's office.

The Committee on Horse-Power presented a paper on the subject of the horse-power of boilers, and received instructions as to the final report, which is to be made next year.

The Committee on Statistics made a report explaining the difficulty in the way of obtaining figures and pointing out the errors of the Census report on the boiler business.

The Committee on Strikes made a report, which was discussed in executive session. This Committee was continued.

The following officers were elected for the ensuing year: President, Philip Rohan; Vice-Presidents, Richard Garstang, Charles Kroeschell and Michael Geary; Treasurer, Richard Hammond; Secretary, E. D. Meier.

It was decided to hold the next meeting in Chicago.

Railroad Telegraph Superintendents' Association.—The eleventh annual meeting was held in Denver, Col., beginning June 15. Four sessions were held, two on each day of the Convention, at which a number of papers were presented and discussed. Committees were appointed on Revision of the Constitution and to prepare a new form of service card.

Among the papers presented were one on Insulation, by T. A. Edison; on Galvanometers, by T. D. Lockwood; on the Government Time System, by Professor W. A. Gardner; on Block Signals, by J. B. Stewart, and on Electricity in Relation to Transportation, by Charles Selden.

It was resolved to hold the next meeting in Milwaukee. The officers elected were: President, L. B. Korty, Omaha; Vice-President, U. J. Fry, Milwaukee; Secretary and Treasurer, P. B. Drew, Chicago.

Master Mechanics' Association.—The officers elected at the Saratoga Convention are: President, John Hickey, St. Paul, Minn.; First Vice-President, William Garstang, Richmond, Va.; Second Vice-President, R. C. Blackall, Albany, N. Y.; Secretary, Angus Sinclair, New York; Treasurer, O. Stewart, Charlestown, Mass.

A summary of the Committee reports presented at the Convention will be found on another page.

Master Car-Builders' Association.—The officers elected at the Convention in Saratoga are: President, E. W. Grieves, Baltimore; First Vice-President, F. D. Casanave, Altoona, Pa.; Second Vice-President, J. S. Lentz, Packerton, Pa.; Third Vice-President, T. A. Bissell, Buffalo, N. Y.; Treasurer, G. W. Demarest, Baltimore; Secretary, John W. Cloud, Chicago; Executive Committee, J. T. Chamberlain, G. W. Rhodes, J. S. Leeds, and J. C. Barber.

THE Secretary announces that the revised Rules of Interchange, which will take effect September 1, are now ready for distribution, and will be furnished railroad companies at the same rate as heretofore.

The Air-Brake and Signal Instructions, as approved at the Saratoga Convention, will also be published in pamphlet form, the cover and size being so arranged as to make them readily distinguishable from the Rules of Interchange. The prices will be the same as for the Rules.

A CIRCULAR from Secretary J. W. Cloud has been issued, submitting two propositions to letter-ballot. The first is on the question of changing the Standard Wheel Guarantee under the heading of "Except in case of Wheels removed for the following causes," so that the first item shall read "Flat or comby by sliding," instead of "Flat by sliding," as now.

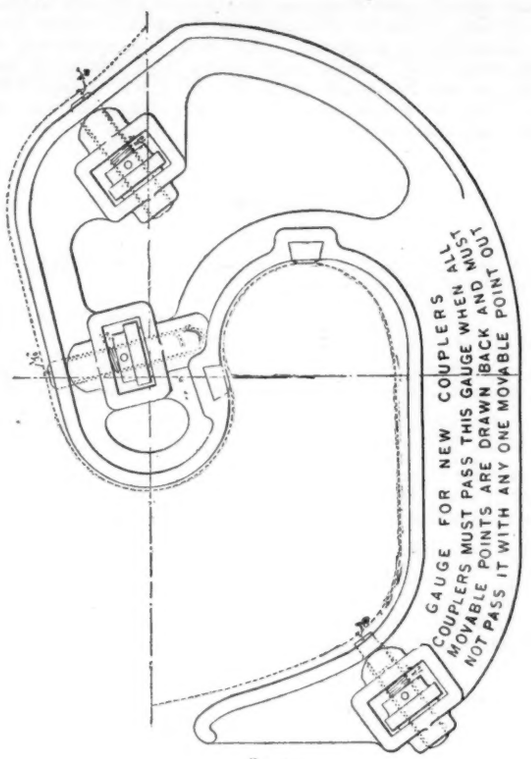

GAUGE FOR NEW COUPLERS ALL
COUPLERS MUST PASS THIS GAUGE WHEN MUST
MOVABLE POINTS ARE DRAWN BACK AND OUT
NOT PASS IT WITH ANY ONE MOVABLE POINT OUT

FIG 1.

Dotted line is Standard Contour.

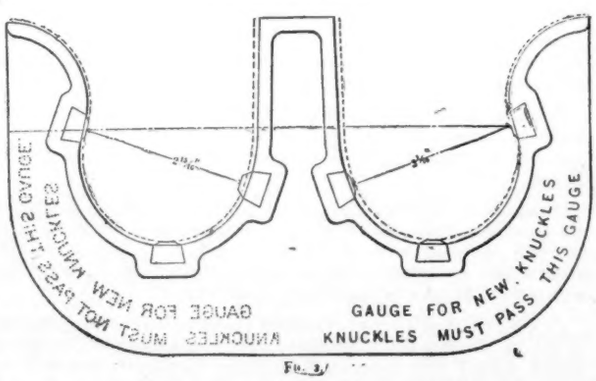


FIG. 2.

GAUGES FOR M. C. B. STANDARD COUPLER.

The second ballot is on the adoption of the coupler gauges shown in figs. 1 and 2 herewith, as standards of the Association.

The votes will be counted on August 31, and votes not received at the Secretary's office before that date will be excluded.

Engineers' Club of Philadelphia.—At the regular meeting, June 18, the Tellers reported the election of Messrs. George C. Thayer and William Elton Mott to Active Membership.

The resignations of Professor L. M. Haupt and Mr. Jesse Garrett were accepted.

Upon motion the Club appointed Mr. Joseph M. Wilson to aid the Committee of the American Society of Civil Engineers by the suggestion of suitable persons to furnish papers for the meeting of the World's Congress Auxiliary of the Chicago Exposition.

A paper by Captain Smith S. Leach, on the Improvement of the Mississippi River, was presented and read by the Secretary. Mr. Trautwine explained that this paper was written, by request, to more fully explain the method of fixing the banks and confining the floods of this river, which had been illustrated by a series of photographs presented some time since by one of the members of the Club.

A communication from Mr. Robert L. Holliday, describing a stone box culvert, built in 1832, south of Newcastle, upon the Delaware Division of the Philadelphia, Wilmington & Baltimore Railroad, was read, and a sample of 2-in. white pine plank, which formed part of its foundation and had been under water for 60 years, was exhibited in connection therewith. The wood showed an excellent state of preservation, and excited much interest.

A section of the first rail used by the Camden & Amboy Railroad was presented by Mr. Rufus Hill, Master Mechanic of the Pavonia Shops. It is believed to be from the first lot of rails made in this country, and was laid November 12, 1831, at Bordentown, N. J. Designed by Mr. R. L. Stevens.

Mr. Wilfred Lewis, upon request, briefly described the recent trip of the American Society of Mechanical Engineers to San Francisco.

Engineers' Society of Western Pennsylvania.—The regular monthly meeting was held in Pittsburgh, June 21. Mr. Alfred E. Hunt in the chair; Mr. R. N. Clark, Secretary.

The paper for the evening was by Mr. W. Lucian Scaife, on Some Data on Rail Joints. In 1885 a paper was read before the Society by Mr. Max J. Becker on Why do Rail Joints Break? This paper caused so much interest that a committee was appointed consisting of Messrs. Thomas Rodd, Max J. Becker, W. H. Borntraeger, the late W. R. Jones, C. L. Strobel, W. L. Scaife, William Scherzer, James G. Dagron and Franz Engstrom. In order to obtain the benefit of the experience of railroad engineers a circular was prepared and sent to most of the railroad companies in the United States and Canada; it contained a list of 25 questions which were believed to cover the subject. In response to these and other circulars, answers were received from engineers, general managers, and superintendents of about 61,000 miles of railroad; many of them were accompanied with drawings of rails, splice-bars, road-beds, nut-locks, etc., and furnished much valuable information outside of the questions contained in the circulars. These were carefully tabulated by Mr. Engstrom at the time hey were received.

Messrs. Max J. Becker, F. Engstrom, Victor Weirman, E. B. Taylor and others joined in the discussion. The Committee by its request was relieved from further duty.

The Society adjourned to September 20.

AT the regular meeting of the Chemical Section on June 28, Mr. R. B. Carnahan, Jr., read an interesting paper on Tin Plate Analysis. He described simple and rapid methods of determining tin, lead, iron, and manganese in tin and terne plate. He also spoke of the determination of tin in solder. His paper was discussed by Messrs. Williams, Camp, Handy and others.

Engineers' Club of Cincinnati.—The subject for discussion at the regular meeting held in June was that of a new water-supply for the city of Cincinnati, which was appropriate at this time on account of the election to be held soon to vote on an appropriation for the purpose, and the new water-works commission to be appointed.

Papers on the subject were prepared by Colonel Latham Anderson, G. Bouscaren, M. D. Burke, and John W. Hill, of Cincinnati, and by Edward Flad, of St. Louis, in addition to which Messrs. Hosea, Whinery, Baldwin, Harper, Ewing, Mathewson and Punshon took part in the discussion.

Several prominent citizens, not members of the Club, were present and were much interested in the proceedings.

Technical Society of the Pacific Coast.—At the regular meeting in San Francisco, July 1. M. P. Boes and G. W. Sherwood were elected members; W. R. Phillips an associate member.

A committee was appointed to prepare a memorial of Andrew Fraser, lately murdered in Mexico.

A paper was read by Mr. Hugo P. Frear, entitled A Problem in Launching the Pacific Mail Steamer *Peru* at the Union Iron Works. The paper was illustrated by diagrams.

Civil Engineers' Club of Cleveland.—The regular meeting of the Club was held at the Club-rooms, June 14. Mr. Irving Mason Wolverton was elected an Active Member. The discussion of the evening was on the annual address of the retiring President, Mr. Gobeille, on the subject of the Financial Status of the Engineer.

THE regular meeting was held in the club rooms July 12. The committee appointed to take action on the death of John Whitelaw, ex-President of the Club and for many years Superintendent of the Cleveland Water Works, made their report. Wendell Phillips Brown was elected an active member.

The paper of the evening was read by Dr. C. S. Howe, of the Case School of Applied Science, and was a Mathematical Discussion of Some Census Reports, with Special Application to the Population of Cleveland, Past and Future.

Engineering Association of the South.—The regular June meeting was held at the Association headquarters in Nashville, Tenn., June 9, Vice-President James Geddes presiding.

After consideration it was decided to hold the regular meetings of the Association on the regular dates, the second Thursday evening of each month, and not to suspend during the summer, as heretofore.

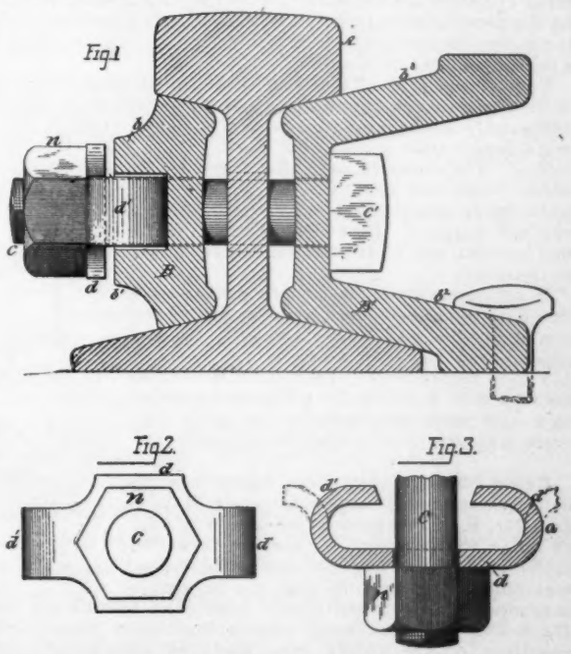
The paper of the evening—Notes on Mine Surveying—was read by Mr. Benjamin W. Robinson, Mining Engineer of the St. Bernard Coal Company of Earlington, Ky.

THE regular July meeting was held in Nashville, July 14; Colonel H. M. Robert, U.S.A., presided.

W. W. Carson, of Knoxville, Tenn., then read a paper on the Mississippi River problem. He spoke briefly of the caving in of the banks of the Mississippi River by the acre; of the vast amount of silt borne by the stream while in flood; and of the heavy deposits which occur where the current is retarded.

NOTES AND NEWS.

A New Rail-Joint.—The accompanying drawing shows a rail-joint recently devised and patented by Mr. G. Bouscaren, of Cincinnati, the well-known engineer. Fig. 1 is a section of the joint; figs. 2 and 3 show the spring washer used in connection with it. In this joint Mr. Bouscaren seeks to avoid the imperfections of existing joints, as he explains in his patent,

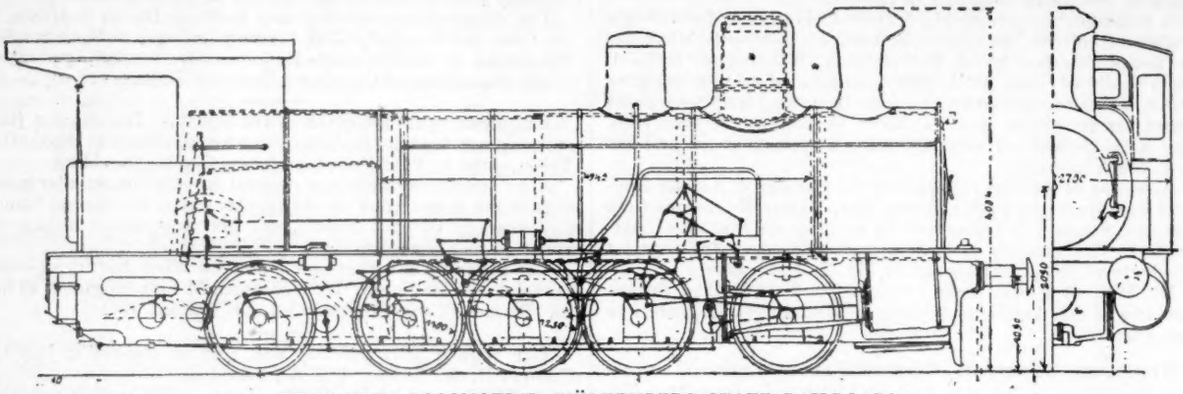


BOUSCAREN'S RAIL-JOINT.

" by employing splice-bars as deep as consistent with the clearance of the flange and tread of the wheels; and my invention consists in the channel form of cross-section of the bars, whereby the distribution of metal in the flanges of the bars is as far as possible removed from the neutral axis and thereby conducive to the greatest resistance; in giving the bars a symmetrical cross-section, whereby the bolt-holes are located on the neutral axis and their weakening effect reduced to a minimum; in the use of a non-rotatable spring-washer of great

power under the nut of each bolt, whose function is to maintain at all times a perfect bearing between the rails and splice-bars, and in providing for the non-rotation of the bolts, thereby assisting to preserve the proper relation of parts. The combination of all these features gives a joint of great strength and durability under both vertical and lateral stresses, which can be cheaply manufactured and easily maintained in the track."

Some Heavy German Locomotives.—Not long ago there were put in service on the Würtemberg State Railroads some extremely powerful locomotives, which are used in freight service on the Göppingen-Gaislingen section, where there are continuous grades of 1 in 100, or 52.8 ft. per mile, and on the adjoining Gaislingen-Ulm section, where the ruling grade is 1 in 44, or 120 ft. per mile.



TEN-WHEEL LOCOMOTIVE, WÜRTEMBERG STATE RAILROADS.

These engines, which are decribed in a recent number of *Glaser's Annalen*, are carried on 10 wheels, all coupled, the connection of the two pairs at the outer ends being by the Klose system. The drivers are 48.3 in. in diameter, and the total wheel-base is 19.7 ft. The total length of the engine over all is 37 ft. The sketch given shows the general outline. The engines are compound, having one high-pressure cylinder placed inside, and two low-pressure cylinders outside; all three cylinders are the same size. They are so arranged that on the heavy grades steam from the boiler is admitted directly to the low-pressure cylinders, the locomotive then working as a three-cylinder simple engine.

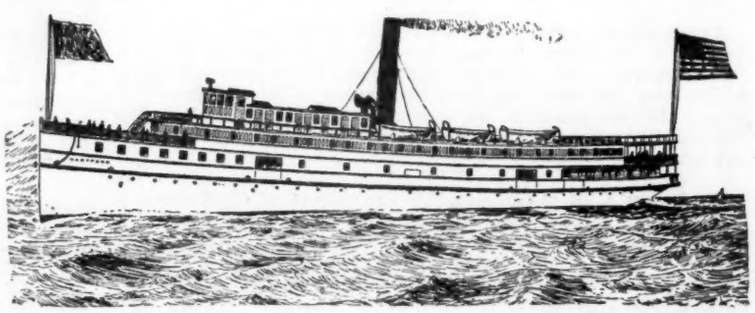
The arrangement of the wheels on the Klose system gives these engines sufficient flexibility to work over sharp curves, while the long wheel-base gives them sufficient stability to run at passenger-train speed, thus making them very useful machines. The object in designing them was to make an engine which could be used for all service, and would do the work which usually required two six-wheeled engines coupled. They are believed to be the heaviest and most powerful engines in use in Germany.

In ordinary service these engines take a train weighing 600 tons up the 1-per cent. grades and one of 300 tons on the 120-ft. grades. On trial trips they have taken trains of 700 tons and 350 tons respectively. They have worked so far very well, handling the trains on the mountain lines more economically and safely than when they were worked with two engines.

Color Photography.—In a lecture recently delivered before the Royal Institution in London, Mr. F. E. Ives described a new process of color photography. This is an invention utilizing comparatively old and familiar photographic processes. It was not a simple invention, but comprised several inventions by different men. By means of a compound camera front three photographic negatives of the object were made by simultaneous and equal exposure, from the same point of view, and upon the same sensitive plate. The photographic plate was sensitive to all colors of light, but by the introduction of light filters one of the negatives was made by such light rays only as excited the fundamental red sensation, and in due proportion another by light rays that excited the fundamental green sensation, and another by light rays that excited the fundamental blue-violet sensation. From this triple negative a triple lantern slide was made which, although it showed no color, contained such a graphic record of the natural colors that, in order to reproduce them to the eye, it was sufficient to superpose the three images, one with red light, one with green, and one with blue-violet. This was accomplished either in his new heliochromoscope—a device about the size of a hand stereoscope, and used in much the same way—or by projection with a special optical lantern, having three optical systems, with red, green and blue glasses. The three images, being exactly superposed, appeared as one only, in which the natural colors were exactly reproduced, together with the light and shade. Images of three ordinary photographs, exactly alike, if superposed in the same way through the same colored glasses, would show no color whatever. The process was as scientifically accurate for reproduction in color as ordinary photography was for reproductions in monochrome, but at present it could be carried out successfully only by a scientific expert employing the photospectrograph for testing the sensitive plates and adjusting the selective color screens. When such preliminary adjustments had been correctly made the process was almost as simple and trustworthy as the ordinary negative process. By a modification of the process, introducing further complication, color prints were made on glass or paper; but the comparative simplicity of the plan of superposing images commended it to scientists and was more convincing to the general public.

A New Sound Steamer.—The accompanying illustration, for which we are indebted to the *Seaboard*, shows a new steamer for Long Island Sound, of a class which is gradually replacing the side-wheel steamers which have for so many years been the prevailing type in the waters around New York.

The new steamer, which is named *Hartford*, has been lately completed by Neafie & Levy, in Philadelphia, for the route between New York and Hartford, Conn. She is an iron boat, 231 ft. long, 40 ft. beam and 13 ft. depth of hold. The passenger accommodations are excellent, the main saloon being on the upper deck and having 44 state-rooms. There is room for a large amount of freight on the lower deck. There is a full electric light plant, including a search-light on the pilot-house. The hull is divided by water-tight bulkheads into a number of compartments.



STEAMBOAT "HARTFORD," LONG ISLAND SOUND.

The *Hartford* is propelled by twin screws, each driven by an independent compound engine with cylinders 20 in. and 40 in. in diameter and 28 in. stroke. Steam is furnished by four tubular boilers 8 ft. diameter and 14 ft. long.

Although of comparatively light draft, as required for her route up the Connecticut River, she has shown very good speed, making 15 knots an hour in regular work.